*The*

# Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VII, No. 7 July, 1916

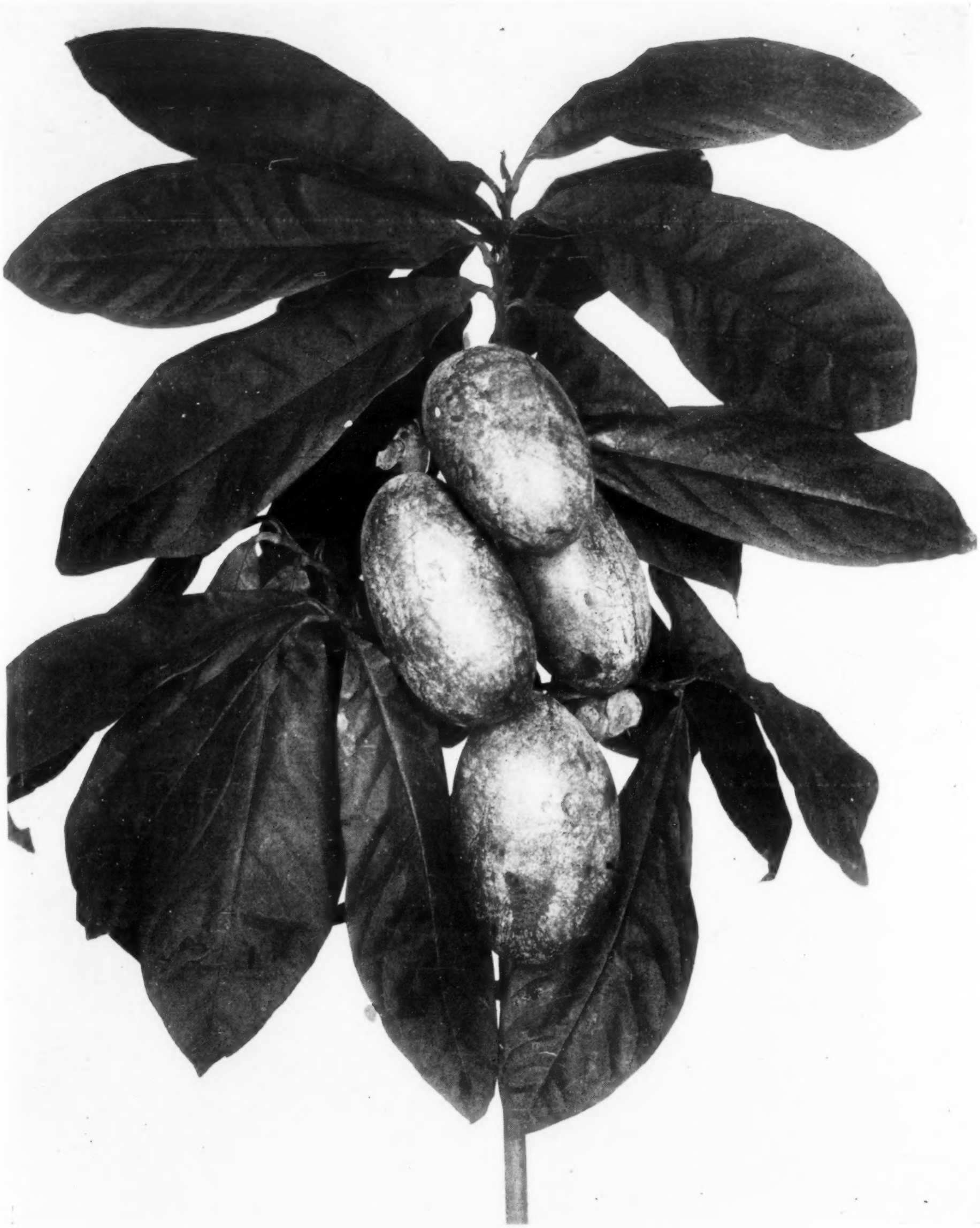
## CONTENTS

Where Are the Best Papaws? ..... 291
Eugenics for Arabic-Speaking Peoples (A review) ..... 296
Feeblemindedness and Charity ..... 296
Musical Ability, by Mrs. Evelyn Fletcher Copp ..... 297
Official Register of Selected Plants in Hungary ..... 305
Crossing Apricots and Peaches with Cherries ..... 305
A Botanical Paradox, by D. F. Higgins ..... 306
The A. G. A. and the A. A. A. S. ..... 306
Let's Positivize Our Negative Eugenics, by A. E. Hamilton ..... 309
Hybrid Trees, by W. H. Lamb (A review) ..... 311
Wanted: A Plant Breeder ..... 319
Eugenics and Military Preparedness ..... 319
Extra Fingers and Toes ..... 320
Origin of the White Blackberry ..... 324
Change of Sex in Hemp, by Frederick J. Pritchard ..... 325
Concerning Prepotency, by The Editor ..... 330

The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912. Contents copyrighted 1916 by the American Genetic Association. Reproduction of articles or parts of articles permitted provided proper credit is given to author and to the Journal of Heredity (Organ of the American Genetic Association), Washington, D. C.

Date of issue of this number, JUNE 26, 1916.



## THE MOST NEGLECTED AMERICAN FRUIT

The papaw, a kind of custard-apple, grows wild in the lower part of the Mississippi Valley, and seems to reach its perfection in Indiana. It is little known even by botanists, and only those who live in the country where it grows are familiar with its value. The American Genetic Association thinks it has much promise of improvement, both by straight selection of the best, and by hydridizing with some of its delicious tropical cousins. A member of the association has made possible an offer of two prizes for information as to where the finest specimens of this fruit can be found; and when they are found, the association hopes to see them put in the hands of a large number of breeders. (Frontispiece.)

# WHERE ARE THE BEST PAPAWS?

## American Genetic Association Offers $100 for Information about Them—A Native Fruit That Has Been Long Neglected But Contains Much Promise

OF ALL the important native fruits of the United States, the least known is probably the papaw,[1] which grows in the forests from the Gulf of Mexico to the Atlantic, west to Oklahoma and as far north as New York and Michigan. As an ornamental tree or shrub, it is occasionally grown even beyond these limits.

Belonging to the family of Annonaceæ or custard-apples, the papaw has a good deal in common with those delicious fruits. Its creamy pulp is of exquisite texture in the mouth, while its distinctive flavor and its aroma, often too pungent, give it a decided individuality. The shiny black seeds occupy more space than is desirable, in most specimens.

The poor shipping quality of the fruit doubtless accounts largely for the fact that it is so little known outside of the immediate localities where it grows wild. It is not considered eatable until it is dead ripe and has begun to turn blackish in color; it sometimes hangs on the tree until Christmas, although it will have reached maturity in the latter half of September, when the flesh is usually yellow, occasionally white. Good individual fruits, according to Little,[2] usually weigh about half a pound apiece, but sometimes they attain a pound in weight.

Not only is it too soft to ship, under most circumstances, but it does not keep well after it is picked. Sometimes it can be held for a number of days, if picked a little firm, but ordinarily it must be eaten from the tree.

The drawbacks of the fruit, then, are largely of a commercial character. They are drawbacks which can probably be removed by intelligent breeding. With this idea a number of individuals have undertaken during the last few years to improve the papaw; but there is still plenty of room for work, and the American Genetic Association therefore feels the desirability of calling attention to the papaw, and pointing out the attractiveness of the problem it offers.

### BEST SEEDLINGS WANTED

Among the wild trees along the creeks and in the underbrush of the river bottoms, there must be many a seedling which combines superior quality with a tougher skin and greater firmness than usual. Probably farmers have picked out some of these trees and transplanted them to the orchard. The American Genetic Association wants to locate these superior trees, in order that they may be made available for rapid propagation; and a member has given $100 as a stimulus to the search for the superior specimens.

Two rewards are offered from this fund. Fifty dollars will be paid for the largest individual tree, and $50 for the tree, regardless of size, which bears the best fruit. The offer will terminate on January 1, 1917, thus including the coming crop-season in which members (or others interested) can keep an eye open for superior specimens.

The award for the largest tree will be made on the basis of photographs. The conditions to be observed are as follows:

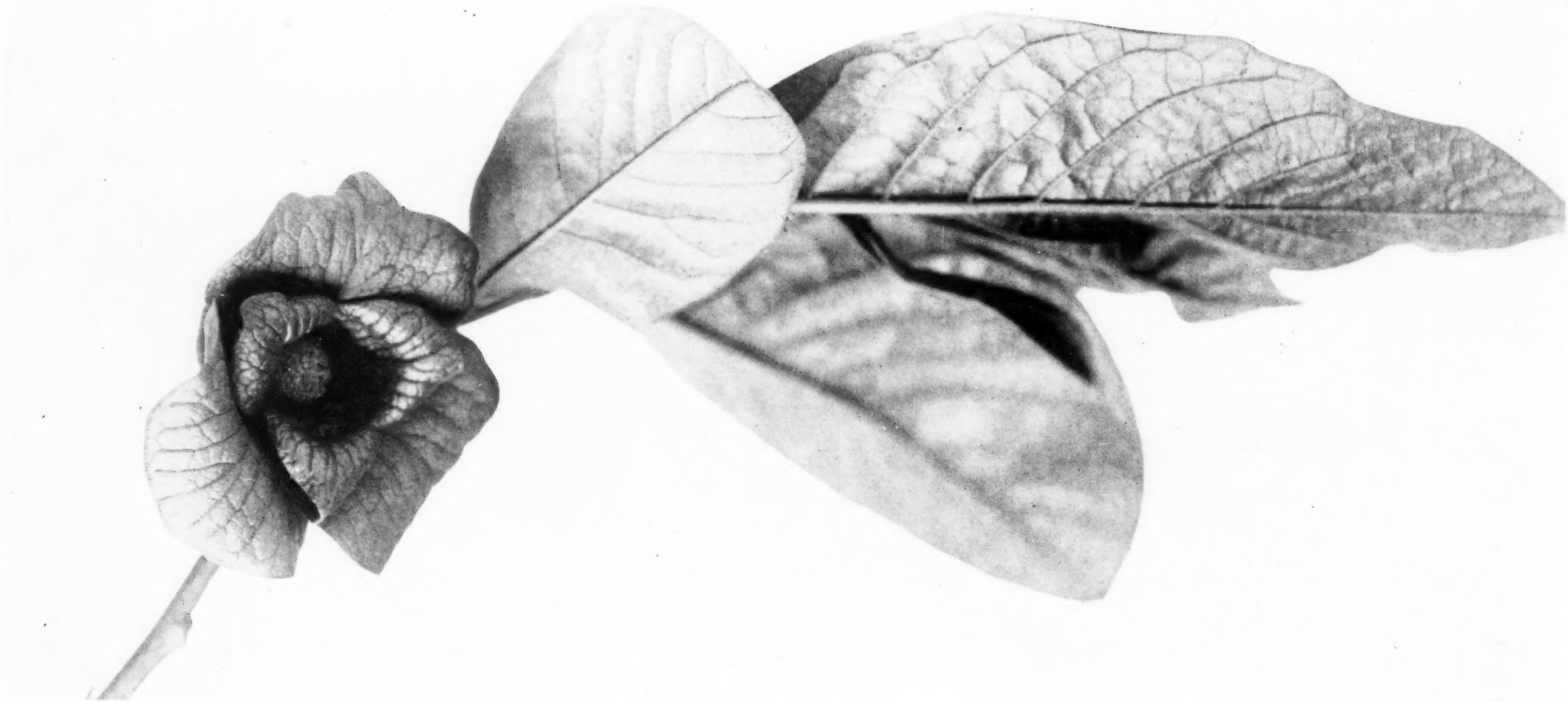
Photographs must be on glossy paper, not smaller than 4 x 5 or 3¼ x 5½ inches, and must be of sufficient excellence to allow reproduction in the JOURNAL OF HEREDITY or elsewhere. Photographs in which the tree is so small that its details cannot be made out, cannot be considered. The measurement of the

[1] *Asimina triloba* Dunal. So little is the papaw known that its very name has been stolen from it and applied, through a confusion in sound, to the tropical papaya or tree-melon (*Carica papaya*) which was described by J. E. Higgins in the JOURNAL OF HEREDITY for May, 1916 (vol. vii, pp. 208–220). The genuine papaw is no more related to this tropical papaya than it is to the apple or strawberry, and the application of the name *papaw* to the papaya should be stopped.

[2] A Treatise on the Papaw, by James A. Little, Cartersburg, Ind. Pp. 18, price 25 cents. This is the only thing published on the subject aside from an occasional magazine article.

**THE PAPAW TREE IS HIGHLY ORNAMENTAL**

It is worth growing around any home, merely for its beauty. Those who know the tree only as it grows in dense thickets can hardly realize what an attractive form it develops when standing by itself and given some care. Its glossy leaves, not unlike those of a magnolia in appearance, attract the eye; even without the added charm of its flowers and fruit, it would be worth a much more conspicuous place in American horticulture than it now holds. The tree can be grown without much difficulty from seed, and is easily grafted. (Fig. 1.)



**FLOWER OF THE PAPAW**

It is not conspicuous, but possesses an individuality which makes it highly prized. It is purplish in color and has been likened to the flower of a hollyhock, although the resemblance is not very close. It lends itself admirably to ornamental arrangement in the Japanese style which is becoming justly popular in the Occident nowadays. (Fig. 2.)

tree must be given in detail. In making it the only method which may be followed is to take the circumference of the trunk at two feet from the ground. It is desirable that the full height of the tree and spread of branches, as well as the girth, should be stated; if they cannot be measured exactly, they should be estimated. Photographs should, when possible, contain some object, such as a human figure, which will aid in giving a realization of the size of the tree; but such figure should be beside, not in front of the tree. It is necessary that the photograph should include the whole tree. If there are other trees growing beside it and cutting off part of it these other trees should be included in the picture. Contestants may send photographs of as many different trees as they like.

With each photograph, a statement should be submitted telling all that is known about the tree, with reference to its age, the size of crop it bears, the quality of the fruit; the character of the soil and surrounding vegetation. It is particularly necessary that photographers should state whether there are many other papaw trees in the neighborhood—within a radius, say, of five miles. If the tree is on private land, and likely to be destroyed, the fact should be mentioned. It will be helpful if photographers can tell to what extent the tree is subject to attacks by disease or insects. In short, the council desires to gain as much information as possible about the papaw trees of the United States; but it imposes as few hard-and-fast restrictions as possible, because of the varying conditions under which photographs may have to be taken, or under which they have been taken at some time in the past.

The tree should be shown with full summer foliage.

All photographs submitted will become the property of the American Genetic Association, to be kept as a scientific record or used in any way that the council may think desirable.

In the award for excellence of fruit, it will not be necessary to submit a photograph of the tree, since many of the best papaws grow in dense thickets where it would be impossible to make a picture. It will be necessary, however, to give a description of the tree from which the fruit is taken, telling approximately how large it is, exactly where located, and whether or not it can be transplanted, or twigs obtained for grafting. The amount of fruit it bears should also be stated. The contestant must send by parcel post to the office of the American Genetic Association, 511 Eleventh Street N. W., Washington, D. C., at least six fruits, all from the same tree, and all ripe enough to be eaten. The award will be made on the basis of the excellence of flavor, small number and size of seeds, but more particularly on the condition in which the fruits reach this office, taking into consideration the number of days they have been in transit; for the great need of the market is for a fruit that will keep and ship well, and if these qualities are once obtained, selection of the best for propagation can be depended on gradually to improve the quality.

The same tree may, of course, be entered for both awards—for size of tree and for quality of fruit.

### CULTIVATED TREES ELIGIBLE

If anyone is cultivating the papaw and has produced a variety that he considers of superior excellence, it will be entirely permissible for him to enter this in competition. The award is not limited to wild trees; although the number of trees in cultivation is believed to be so small that it is probable some of the many wild trees will be found superior to anything known in orchards.

It is the hope of this association that the superior trees found will be propagated by grafting, and a large quantity of them secured within a few years. The papaw can be grown from seed, but only with difficulty from suckers, while transplanting is recognized to offer much trouble. One correspondent describes the general experience when he says, "I have been growing papaws for seventy-five years, not willingly but because I could not help it. It is claimed there is no way to kill a papaw except to transplant it and try to make it grow."

Grafting in the spring has been found to offer no great obstacles, however, and is the best means of propagation, from the plant-breeder's point of view. Budding has not given good results, but this may be due to wrong technique. So far as is recorded, the papaw has not been grafted on any stock except its own, and there appears to be no necessity for any other stock.

One of the promising fields for plant-breeding, in connection with the papaw, appears to be in hybridizing it with its close relatives, the tropical annonas, the genus which includes the bullock's-heart, sweet-sop, sour-sop, and the

incomparable custard-apple or cherimoya. These fruits are larger and finer than the papaw, but too tender to grow in the United States except in southern California and southern Florida. There would appear to be a good chance that they could be crossed with the papaw, and a fruit produced

**THE PAPAW**

Cross section of a fruit, natural size, photographed by W. E. Rumsey, of the West Virginia Experiment Station. The flesh is ordinarily yellow but sometimes white, and custard-like in consistency, with a peculiar pungent aroma. (Fig. 3.)

which would be hardy in a large part of the United States, while superior in quality to the papaw itself. So far as is recorded, this cross has never been made.

### PROPAGATION FROM SEED

It may be helpful to give the advice of the late James A. Little on the propagation of the papaw. To grow seedlings, he writes, "My plan, which has been entirely successful, is to make a hill like a watermelon hill and plant about five seeds two or three inches deep in the fall. In part for protection but mainly for shading the plants when they come up I place a barrel with both heads out over the hill and let it remain for a year or two. After that the barrel may be removed and then the plants will bear the sun. It must not be expected that the plants will come up until the harvest or later. The plants will not get more than 2 or 3 inches high the first year, but the root will be proportionately much larger than the top. The second year the plants will grow 6 or 8 inches high and after that they will greatly increase in growth from year to year. It will take them six or eight years to come into bearing."

More recent experiments than those of Mr. Little indicate that if planted as soon as taken from the fruits the seeds lie dormant in the soil for one year and germinate the second spring. There appears to be little difficulty in transplanting the young seedlings from the seed bed to the nursery row and getting plants 12 to 18 inches tall in two years, providing they are grown in rich garden earth. Transplanting has to be done in the spring before any growth starts.

Finally, as the season of ripening is coming on, it will be of interest to quote Mr. Little on the value of the fruit.

"The principal use of the papaw," he writes, "is to eat from the hand but there are other uses that it can be put to. It makes splendid custard pie. There is no finer dessert than papaw eaten with cream and sugar. It is used to make beer the same as the persimmon by putting the fruit in a jar, mashing it, and putting water on it and letting it stand until fermented. It also answers to make pudding just the same as persimmon pudding is made. It is also said that brandy equal to peach brandy is made of papaws. Marmalade which is equal to that of pears or peaches may be made of papaw. The custard may be spread on a board and dried like

tree must be given in detail. In making it the only method which may be followed is to take the circumference of the trunk at two feet from the ground. It is desirable that the full height of the tree and spread of branches, as well as the girth, should be stated; if they cannot be measured exactly, they should be estimated. Photographs should, when possible, contain some object, such as a human figure, which will aid in giving a realization of the size of the tree; but such figure should be beside, not in front of the tree. It is necessary that the photograph should include the whole tree. If there are other trees growing beside it and cutting off part of it these other trees should be included in the picture. Contestants may send photographs of as many different trees as they like.

With each photograph, a statement should be submitted telling all that is known about the tree, with reference to its age, the size of crop it bears, the quality of the fruit; the character of the soil and surrounding vegetation. It is particularly necessary that photographers should state whether there are many other papaw trees in the neighborhood—within a radius, say, of five miles. If the tree is on private land, and likely to be destroyed, the fact should be mentioned. It will be helpful if photographers can tell to what extent the tree is subject to attacks by disease or insects. In short, the council desires to gain as much information as possible about the papaw trees of the United States; but it imposes as few hard-and-fast restrictions as possible, because of the varying conditions under which photographs may have to be taken, or under which they have been taken at some time in the past.

The tree should be shown with full summer foliage.

All photographs submitted will become the property of the American Genetic Association, to be kept as a scientific record or used in any way that the council may think desirable.

In the award for excellence of fruit, it will not be necessary to submit a photograph of the tree, since many of the best papaws grow in dense thickets where it would be impossible to make a picture. It will be necessary, however, to give a description of the tree from which the fruit is taken, telling approximately how large it is, exactly where located, and whether or not it can be transplanted, or twigs obtained for grafting. The amount of fruit it bears should also be stated. The contestant must send by parcel post to the office of the American Genetic Association, 511 Eleventh Street N. W., Washington, D. C., at least six fruits, all from the same tree, and all ripe enough to be eaten. The award will be made on the basis of the excellence of flavor, small number and size of seeds, but more particularly on the condition in which the fruits reach this office, taking into consideration the number of days they have been in transit; for the great need of the market is for a fruit that will keep and ship well, and if these qualities are once obtained, selection of the best for propagation can be depended on gradually to improve the quality.

The same tree may, of course, be entered for both awards—for size of tree and for quality of fruit.

### CULTIVATED TREES ELIGIBLE

If anyone is cultivating the papaw and has produced a variety that he considers of superior excellence, it will be entirely permissible for him to enter this in competition. The award is not limited to wild trees; although the number of trees in cultivation is believed to be so small that it is probable some of the many wild trees will be found superior to anything known in orchards.

It is the hope of this association that the superior trees found will be propagated by grafting, and a large quantity of them secured within a few years. The papaw can be grown from seed, but only with difficulty from suckers, while transplanting is recognized to offer much trouble. One correspondent describes the general experience when he says, "I have been growing papaws for seventy-five years, not willingly but because I could not help it. It is claimed there is no way to kill a papaw except to transplant it and try to make it grow."

Grafting in the spring has been found to offer no great obstacles, however, and is the best means of propagation, from the plant-breeder's point of view. Budding has not given good results, but this may be due to wrong technique. So far as is recorded, the papaw has not been grafted on any stock except its own, and there appears to be no necessity for any other stock.

One of the promising fields for plant-breeding, in connection with the papaw, appears to be in hybridizing it with its close relatives, the tropical annonas, the genus which includes the bullock's-heart, sweet-sop, sour-sop, and the

incomparable custard-apple or cherimoya. These fruits are larger and finer than the papaw, but too tender to grow in the United States except in southern California and southern Florida. There would appear to be a good chance that they could be crossed with the papaw, and a fruit produced

**THE PAPAW**

Cross section of a fruit, natural size, photographed by W. E. Rumsey, of the West Virginia Experiment Station. The flesh is ordinarily yellow but sometimes white, and custard-like in consistency, with a peculiar pungent aroma. (Fig. 3.)

which would be hardy in a large part of the United States, while superior in quality to the papaw itself. So far as is recorded, this cross has never been made.

### PROPAGATION FROM SEED

It may be helpful to give the advice of the late James A. Little on the propagation of the papaw. To grow seedlings, he writes, "My plan, which has been entirely successful, is to make a hill like a watermelon hill and plant about five seeds two or three inches deep in the fall. In part for protection but mainly for shading the plants when they come up I place a barrel with both heads out over the hill and let it remain for a year or two. After that the barrel may be removed and then the plants will bear the sun. It must not be expected that the plants will come up until the harvest or later. The plants will not get more than 2 or 3 inches high the first year, but the root will be proportionately much larger than the top. The second year the plants will grow 6 or 8 inches high and after that they will greatly increase in growth from year to year. It will take them six or eight years to come into bearing."

More recent experiments than those of Mr. Little indicate that if planted as soon as taken from the fruits the seeds lie dormant in the soil for one year and germinate the second spring. There appears to be little difficulty in transplanting the young seedlings from the seed bed to the nursery row and getting plants 12 to 18 inches tall in two years, providing they are grown in rich garden earth. Transplanting has to be done in the spring before any growth starts.

Finally, as the season of ripening is coming on, it will be of interest to quote Mr. Little on the value of the fruit.

"The principal use of the papaw," he writes, "is to eat from the hand but there are other uses that it can be put to. It makes splendid custard pie. There is no finer dessert than papaw eaten with cream and sugar. It is used to make beer the same as the persimmon by putting the fruit in a jar, mashing it, and putting water on it and letting it stand until fermented. It also answers to make pudding just the same as persimmon pudding is made. It is also said that brandy equal to peach brandy is made of papaws. Marmalade which is equal to that of pears or peaches may be made of papaw. The custard may be spread on a board and dried like

pumpkin leather. Papaws may be kept in their natural state till midwinter or longer by laying them down in oats. At this present date, January 27, Mr. Thompson has them down in oats that are just as good as when taken from the tree." On this last point, another correspondent writes that he has found no better place to store them than in the dry leaves at the base of the tree.

---

## Eugenics for Arabic-Speaking Peoples

Hall al-'Uqdah bi-Mulakhkhas al-Ifâdah fî Intâj al-Awlâd hasab al-Irâdah (The Untying of the Knot in a Comprehensive Resumé on the Production of Children according to Will), by A. J. Arbeely, M.D. Pp. 193, price, $2.50. Published by the author, 1723 U Street N.W., Washington, D. C.

The title of this book, implying that it is devoted to sex-control, fails adequately to describe its nature, for the theory of sex-control (based on nutrition and the influence of the parental mind) occupies only a third of the book, although it is said to be based on 1,000 cases. In the first two-thirds of the book the author, a Syrian physician with forty years of experience, gives a general treatise on eugenics, marriage and parenthood. It is written in a wholesome tone, with abundant detail, and gives an amount of information about heredity and race betterment which has not hitherto been available in the Arabic language, although the ancient Arabs had some sound empirical ideas on the subject. Muhammad is reported to have commanded, "Select your wives with a view to offspring," and again to have said, "Avoid the rank plant which grows on a dung-hill." When asked to explain this he replied, "I had in mind the woman who is beautiful but whose ancestry is bad." Marriage and parenthood were held in the highest esteem, but the veneration of them was sometimes carried to an extreme, as is reflected in another saying credited to the prophet, "A fecund black wife is preferable to a sterile white one." Dr. Arbeely does not attempt to discuss this phase of the subject, which offers an attractive field of research for some Orientalist. It should be added that the literary style of the author is admirable, as those who know his lexicographic and journalistic work would expect.

---

## Feeblemindedness and Charity

More than half of the men who, in New York, apply to the Joint Application Bureau for Aid or patronize the Municipal Lodging House are morons, according to the estimate of Charles B. Barnes, Director Bureau of Employment of the State of New York. If careful examination should prove his estimate to be correct, he says, "it would mean an entire change in the attitude of the courts, charitable organizations, and the public generally toward them. We would no longer seek to 'rehabilitate' them. The long and weary path of attempting to make them self-supporting would be abandoned. The attempt to 'reform' them, in the sense in which it is now used, or the obtaining from them of promises to reform, would not be made. Other disposition would have to be made of them. We would commence to treat our mentally defective as well and with as much consideration as we now treat our physically defective, and no more stigma would be attached to the one than to the other." For treating the feebleminded among the applicants for charity, he declares that the farm colony with forcible detention is the only practical plan; by this means most of them could be made self-supporting, while at the present time most of them are annually costing society far more than they earn. On economic as well as humanitarian grounds, therefore, a revision of methods of distributing charity, which would eliminate the feebleminded, appears to be justified.

# MUSICAL ABILITY

## Bases of it Inherited by Nearly Everyone—Difference in Ability Due More to Training Than to Heredity—Means for Bringing Latent Ability Into Expression

MRS. EVELYN FLETCHER COPP, *Brookline, Mass.*

IT IS generally supposed that musicians are born, not made. A modern student of heredity, for example, writes of musical ability:

"This quality is one that develops so early in the most marked cases that its innateness cannot be questioned. A Bach, matured at 22; a Beethoven, publishing his compositions at 13 and a Mendelssohn at 15; a Mozart, composing at 5 years, are the product of a peculiar protoplasm of whose tenacious qualities we get some notion when we learn that the Bach family comprised twenty *eminent* musicians and two-score others less eminent."

Following out this line of attack, let us look a little further for evidence that musical ability is innate. Of the Bach family I shall not speak, for its history is well-known: it presents an amount of musical genius unrivaled in history. But if we examine the ancestry of other great musicians, including some of those mentioned by the writer just quoted, we find little to indicate that their preeminent musical ability was due to any extraordinary combination of heredity.

Among such cases is Haydn. His father was a wheelwright, his mother had been a cook and, although both were fond of music, neither could be reckoned a musician as we diagnose the term. Schubert is another example; and the immortal Robert Schumann had no ancestors who were even slightly addicted to music. Even the musicians who can point to a musical parent or grandparent have, in many striking instances, seemingly failed to transmit to their offspring even a trace of their stupendous ability. Another interesting point which strikes even the casual observer of the musicians of the past is that musical heredity seems to be anti-suffrage. When heredity might seem to have caused musical ability in the sons, the daughters seem usually not to have been extraordinarily benefited; and in this connection it is also of interest to note that, while many women have excelled as vocal or instrumental performers, the originality necessary to musical composition has been conspicuously lacking and there are no women who come even within hailing distance of Beethoven, Mozart, Handel and a dozen other men we might name.

### A COMMON INHERITANCE

Now, I do not propose to argue from these facts that musical ability is not a matter of heredity. I think it is a matter of heredity, but that *almost everyone possesses the heredity*. Twenty years of teaching give me reason to believe that, although great genius will doubtless continue to be sporadic and unaccountable, real musical ability is much more common than has been supposed. Genius, like murder, will out. It cannot be suppressed by environmental obstacles, but talent, often overlooked, may be discovered and brought to great perfection. It seems, indeed, that music, like poetry, may be a primal talent; that, as all children are born poets, they may also be born musicians and also, very similarly, that as 99% of humanity lose all poetic faculty during the years of early childhood because of the artificial conditions of modern child life, so the very large majority of children lose their native musical ability through lack of training of the ear and mind during their most susceptible period. Education should come to the help of heredity to reclaim and develop man's natural gift.

We are all born with ears and they are formed for hearing as the eye is for seeing; they are, moreover, capable of hearing far more and better than they

**ACQUIRING A SUPPOSEDLY INBORN GIFT**

Positive Pitch—the ability to name a musical note when it is sounded—has often been considered a rare, inborn trait which marked its possessor as particularly fortunate in the inheritance of musical ability. Recent evidence, however, indicates that it is by no means a sharply inherited character, but a function of the mind which can be acquired by almost anyone, with proper training. The children here photographed are acquiring Positive Pitch in an interesting way: one of them sounds notes on the piano, the two blindfolded ones name the notes, and the boy at the table then locates them on the staff, by means of wooden symbols. (Fig. 4.)

are accustomed to doing. We carry them around with us everywhere, but we really pay very little attention to them. We let our children speak in a slip-shod, indistinct way and we listen carelessly. We leave good talking and singing to the professional musicians and orators, which is just as unreasonable as to leave good seeing to the professional artist and poet. We are only just beginning to learn what the normal ear is capable of, for instance in the matter of Positive Pitch, that is, ability to recognize and name musical tones. The lay public has been accustomed to consider Positive Pitch as a gift wrapped in the exclusive tissue of genius and doled out to the ultra musical only. One who can enter a room where a musician is singing or playing and say, "He is singing high C, or baritone B," has hitherto been looked upon as a prodigy. This is by no means necessarily true. By proper training this power may be acquired, speaking very conservatively, by 80% of normal children. Children who have been thought to be entirely lacking in musical ability, some of them apparently tone deaf, after a few months of training are able to sing "Center C" on demand and to recognize it when it is played or sung and they soon become equally familiar with the other musical tones.

### HUNDREDS OF CASES STUDIED

I base this statement on the experience of having taught some hundreds of children; the corroborative experience of the teachers I have trained would add hundreds more cases. Certainly I do not say that every one can acquire, by training, this once mysterious gift of Positive Pitch, but I know that most people can do so, if they begin at an early age.

This surely indicates that musical talent is much more widespread than has been thought and that the cases we have quoted of the appearance of wonderful ability in the children of seemingly non-musical parents, may be merely instances of the inheritance of latent characters.

Some children will, of course, not acquire Positive Pitch as quickly as others. There are children who do not so easily learn to write English from dictation as others; but do we therefore allow them to give up and say that they cannot be taught? By the time he is ten or twelve any normal child can learn to write correctly from dictation five hundred words or more. Now, taking every white and black key on the piano there are only eighty-eight. Given a fair chance and a mind unmesmerized by the idea that reading music and Positive Pitch are difficult and require special gift, a child may as easily see mentally the sign for any sound as he sees the words that he hears you dictate to him in English.

That the results of music study have hitherto been so meagre is due to parental indifference and the faultiness of the methods of teaching music. Teachers have insisted that the child should not be allowed to play the piano by ear, claiming that this will ruin his musical ear and make reading by sight impossible! Fancy a mother fearing that if her child speaks English first by ear, he will never learn to read it! As music is primarily an art making its first and greatest appeal through the ear, it is unreasonable to suppress the interest and initiative which naturally appear first through the ear and then, later on, by laborious ear training lessons to try to get back the interest and power which we have ignored during the most formative period of the child's life.

### MUSIC EASILY ACQUIRED

The acquirement of musical education is or should be comparatively easy, not only because of the smallness of the musical vocabulary (consisting as we have said of only eighty-eight tones), but also because of the universality of its notation. The present system of musical notation, though perhaps not perfect, has this great advantage, that it is the same all over the civilized world, so that when one learns it in America, the musical thoughts of France, Spain, Germany, Italy or Russia are equally accessible. A child

**LEARNING THE TIME-DIVISIONS OF MUSIC**

A sense of ryhthm has long been considered innate, but recently psychologists have brought forward some evidence to indicate that it may be merely the result of early training. Whether this be true or not, it is certain that many persons have a defective feeling for and knowledge of the time-divisions of modern music. Children are now being taught the value of half-notes, quarter-notes, rests, etc., by means of blocks of various lengths, and the mental conception of these things becomes so clear and simple that they are allowed to give physical expression to what they have so easily understood, by marching, clapping and acting the musical passage. (Fig. 5.)

**A LESSON IN MODULATION**

As against the view of extreme eugenicists, that musical ability is an inherited trait, which you either do or do not get from your parents, many psychologists claim that music is a universal, natural method of self-expression, and that every normal individual possesses the ability to develop it just as he possesses the ability to develop the power of expressing himself in English, or whatever his mother tongue may be. The numerous individuals who are considered or consider themselves "absolutely unmusical" are held to be the results of lack of education, or wrong methods of education, in this form of expression. Mrs. Fletcher-Copp has found that children, if allowed to develop their ability in a natural way, can soon reach achievements that many adults of long training cannot surpass. This photograph shows one of her means of teaching children modulation. By this simple piece of apparatus, on which different chords can be represented by movable pegs, no less than fifteen different simple ways of modulating can be easily taught to any child. With such a stock of experience, he will know more than the average teacher. Of 700 music teachers. Mrs. Fletcher-Copp says she found only three who could modulate easily and happily, and they did not pretend to understand what they were doing. (Fig. 6.)

learns to read English easily and well during the first six years of his school life (that is from the age of six to twelve); he might just as easily learn during the same time to read fearlessly and well the universal language of Music.

If you were to visit a public school and express surprise that the washwoman's daughter reads as well as the child of your own cultured neighbor, you would be told that "thanks to the System," the advantages of birth are being wonderfully counterbalanced; that, though the effects of a few generations of culture may tell in other ways, no one is dependent upon his

forefathers for ability to read, spell or write. Scientific teaching makes these things possible to all mankind.

Exactly as normal is the ability to learn to read and think music.

The first conclusion, then, which I venture to lay before students of heredity, is that they have, with the material at present available, no proper ground for drawing conclusions as to the distribution of musical talent in the population; because there is a great deal which is merely latent, having been denied the possibility of expression. The inheritance of a trait and the expression of a trait are two different things. No student of heredity would consciously ignore the distinction, but in the study of the inheritance of musical ability they have unconsciously ignored it, and therefore their results do not correspond with the reality.

Time and again, as I have said, I have taken children from families where there was apparently no musical ability, and where the child himself was supposed to be utterly deficient in music. The student of heredity, I fear, would unhesitatingly have set down such a child as non-musical because of failure to inherit the prerequisites. Yet this child, after being educated in a natural manner, has acquired Positive Pitch, has learned to compose, to express his own feelings musically, and to analyze compositions which would baffle many teachers.

Thus, although a child may come from a supposedly unmusical family, it by no means follows that the child cannot develop musical ability of a high order. On the other hand, what of the cases where the child of two musical parents fails to show talent?

I have in mind one striking case of this sort which I met years ago. The father was a pianist of international renown, the mother a gifted musician. They hoped, of course, that their child, with its double inheritance, would surpass either one of them: they confidently expected such a result. The child was set to studying music at an early age, but made no progress whatever; he was declared to be dull, uninterested, hopeless.

I was naturally curious to find the reason for this state of affairs: and they were not hard to find. Almost the first inquiry I made disclosed the fact that the child showed a dislike for tedious hours of practicing, and was therefore frequently shut up in a dark closet for an hour or two at a time, to instil in him a greater love for his lessons, and a spirit more obedient to the wishes of his parents. Small wonder that he lost interest in music; and without interest, without an eagerness to learn, little can be done. But where the interest and will exist, it is an unusually defective child that cannot acquire a considerable amount of musical ability; and the same to a less extent holds good of adults.[1] Perhaps it may be of interest if I explain in a little detail the views on this point to which twenty years of teaching have brought me.

If the motive for studying music be made clear and the method of teaching be sound, we may count confidently on the results. Browning says, "It is better Youth should strive, through acts uncouth, towards making, than

---

[1] This view has been developed of late years by a number of psychologists. In the Archiv für die gesamte Psychologie, XXXIV, 12, pp. 235–253 (Leipzig, 1915), Siegfried Bernfeld of Vienna cites two university students whom he studied, each of whom was supposed to be utterly unmusical, until the exertion of the will, as he says, led to the development of considerable enjoyment of music. He concludes: "The individual's reaction to music is by no means wholly decided by the nature and quantity of his psychophysical tendencies. It is influenced to a certain degree by the will to be or not to be musical . . . Even when accurate tests have shown that a person possesses all the elements of musical ability, it cannot be foretold with certainty whether he can acquire musical appreciation, for it is possible that an inhibition with retroactive force against music may exist in him, a will to be unmusical, or at least to seem so to himself and others." Cf. also Sterne, die differentielle Psychologie (1911), p. 265. For the opposite view, that heredity is the primary factor, consult Hans Rupp, Ueber die Prüfung musikalischen Fähigkeiten; Ztschft. f. die angewandte Psychol., IX, Nos. 1 and 2; also C. B. Davenport, Heredity in Relation to Eugenics (New York, 1911), p. 48. The psychological literature on music is large; for an interesting account of how musical ability is measured see Carl Emil Seashore, Psychology in Daily Life (New York, 1913), pp. 196 ff.—The Editor.

**COMPOSITION OF A 13-YEAR-OLD BOY**

Acting on the principle that music is as natural a form of self-expression as are words, Mrs. Fletcher-Copp tries to get children to express their feelings in this way. The above composition represents the thought of a 13-year old boy after studying a picture called "The Last Outpost," in which an Indian who has been driven from the ancestral hunting-ground of his tribe contemplates the waters of the Pacific with the thought that if he is again forced by the white man to move, it can only be into the ocean. (Fig. 7.)

repose on aught found made." We have made the mistake in music teaching in the past of putting the finished product of another's mind before our children and forcing them to copy it. Behind this mistake is the wrong motive. The main idea was to force the child to copy, parrot-like, at the earliest possible moment, the thoughts of some one else. Music was looked upon merely as a means of adornment, as something to be plastered on the outside to add to the attractiveness of the child. The motive is altogether wrong. Not slavery to someone else's ideas but freedom to express one's own ideas should be the aim. Watch a tiny child seated on his mother's knee. She has been playing and he has been told to keep his little paddies on her wrists, but presently he pushes her hands aside and substitutes for the beautiful composition his own incoherent pattings and poundings of the keys, striving "through sounds uncouth" to express himself; but, alas! he is stopped. It is as though a two-year-old should toddle to his mother and stammer with his crooked little tongue, "See, mama, ve sun is playing hide and go seek wif me," and the mother should say, "You must not talk that way, my child. You should say, as Homer writes, 'Lo! Dawn the rosy-fingered, opes wide the gates of Day.'" What would be the effect of this classical method of teaching English upon one's joy and proficiency in acquiring the mother tongue?

### METHODS OF EDUCATION

The motive, then, for learning musical notation must be for the purpose of freeing the child by giving him the means of expressing his own ideas on paper as well as giving him pleasure in reading easily and joyfully the thoughts of others. The means used for the attainment of these ends are most important. They must cultivate as many of the child's senses as possible. If he can feel the symbols as well as see them; if he may see them in a big, tangible form; then through this touch contact and through this ready sight, it

**ACQUIRING A SUPPOSEDLY INBORN GIFT**

Positive Pitch—the ability to name a musical note when it is sounded—has often been considered a rare, inborn trait which marked its possessor as particularly fortunate in the inheritance of musical ability. Recent evidence, however, indicates that it is by no means a sharply inherited character, but a function of the mind which can be acquired by almost anyone, with proper training. The children here photographed are acquiring Positive Pitch in an interesting way: one of them sounds notes on the piano, the two blindfolded ones name the notes, and the boy at the table then locates them on the staff, by means of wooden symbols. (Fig. 4.)

are accustomed to doing. We carry them around with us everywhere, but we really pay very little attention to them. We let our children speak in a slip-shod, indistinct way and we listen carelessly. We leave good talking and singing to the professional musicians and orators, which is just as unreasonable as to leave good seeing to the professional artist and poet. We are only just beginning to learn what the normal ear is capable of, for instance in the matter of Positive Pitch, that is, ability to recognize and name musical tones. The lay public has been accustomed to consider Positive Pitch as a gift wrapped in the exclusive tissue of genius and doled out to the ultra musical only. One who can enter a room where a musician is singing or playing and say, "He is singing high C, or baritone B," has hitherto been looked upon as a prodigy. This is by no means necessarily true. By proper training this power may be acquired, speaking very conservatively, by 80% of normal children. Children who have been thought to be entirely lacking in musical ability, some of them apparently tone deaf, after a few months of training are able to sing "Center C" on demand and to recognize it when it is played or sung and they soon become equally familiar with the other musical tones.

### HUNDREDS OF CASES STUDIED

I base this statement on the experience of having taught some hundreds of children; the corroborative experience of the teachers I have trained would add hundreds more cases. Certainly I do not say that every one can acquire, by training, this once mysterious gift of Positive Pitch, but I know that most people can do so, if they begin at an early age.

This surely indicates that musical talent is much more widespread than has been thought and that the cases we have quoted of the appearance of wonderful ability in the children of seemingly non-musical parents, may be merely instances of the inheritance of latent characters.

Some children will, of course, not acquire Positive Pitch as quickly as others. There are children who do not so easily learn to write English from dictation as others; but do we therefore allow them to give up and say that they cannot be taught? By the time he is ten or twelve any normal child can learn to write correctly from dictation five hundred words or more. Now, taking every white and black key on the piano there are only eighty-eight. Given a fair chance and a mind unmesmerized by the idea that reading music and Positive Pitch are difficult and require special gift, a child may as easily see mentally the sign for any sound as he sees the words that he hears you dictate to him in English.

That the results of music study have hitherto been so meagre is due to parental indifference and the faultiness of the methods of teaching music. Teachers have insisted that the child should not be allowed to play the piano by ear, claiming that this will ruin his musical ear and make reading by sight impossible! Fancy a mother fearing that if her child speaks English first by ear, he will never learn to read it! As music is primarily an art making its first and greatest appeal through the ear, it is unreasonable to suppress the interest and initiative which naturally appear first through the ear and then, later on, by laborious ear training lessons to try to get back the interest and power which we have ignored during the most formative period of the child's life.

### MUSIC EASILY ACQUIRED

The acquirement of musical education is or should be comparatively easy, not only because of the smallness of the musical vocabulary (consisting as we have said of only eighty-eight tones), but also because of the universality of its notation. The present system of musical notation, though perhaps not perfect, has this great advantage, that it is the same all over the civilized world, so that when one learns it in America, the musical thoughts of France, Spain, Germany, Italy or Russia are equally accessible. A child

**LEARNING THE TIME-DIVISIONS OF MUSIC**

A sense of ryhthm has long been considered innate, but recently psychologists have brought forward some evidence to indicate that it may be merely the result of early training. Whether this be true or not, it is certain that many persons have a defective feeling for and knowledge of the time-divisions of modern music. Children are now being taught the value of half-notes, quarter-notes, rests, etc., by means of blocks of various lengths, and the mental conception of these things becomes so clear and simple that they are allowed to give physical expression to what they have so easily understood, by marching, clapping and acting the musical passage. (Fig. 5.)

**A LESSON IN MODULATION**

As against the view of extreme eugenicists, that musical ability is an inherited trait, which you either do or do not get from your parents, many psychologists claim that music is a universal, natural method of self-expression, and that every normal individual possesses the ability to develop it just as he possesses the ability to develop the power of expressing himself in English, or whatever his mother tongue may be. The numerous individuals who are considered or consider themselves "absolutely unmusical" are held to be the results of lack of education, or wrong methods of education, in this form of expression. Mrs. Fletcher-Copp has found that children, if allowed to develop their ability in a natural way, can soon reach achievements that many adults of long training cannot surpass. This photograph shows one of her means of teaching children modulation. By this simple piece of apparatus, on which different chords can be represented by movable pegs, no less than fifteen different simple ways of modulating can be easily taught to any child. With such a stock of experience, he will know more than the average teacher. Of 700 music teachers. Mrs. Fletcher-Copp says she found only three who could modulate easily and happily, and they did not pretend to understand what they were doing. (Fig. 6.)

learns to read English easily and well during the first six years of his school life (that is from the age of six to twelve); he might just as easily learn during the same time to read fearlessly and well the universal language of Music.

If you were to visit a public school and express surprise that the washwoman's daughter reads as well as the child of your own cultured neighbor, you would be told that "thanks to the System," the advantages of birth are being wonderfully counterbalanced; that, though the effects of a few generations of culture may tell in other ways, no one is dependent upon his

forefathers for ability to read, spell or write. Scientific teaching makes these things possible to all mankind.

Exactly as normal is the ability to learn to read and think music.

The first conclusion, then, which I venture to lay before students of heredity, is that they have, with the material at present available, no proper ground for drawing conclusions as to the distribution of musical talent in the population; because there is a great deal which is merely latent, having been denied the possibility of expression. The inheritance of a trait and the expression of a trait are two different things. No student of heredity would consciously ignore the distinction, but in the study of the inheritance of musical ability they have unconsciously ignored it, and therefore their results do not correspond with the reality.

Time and again, as I have said, I have taken children from families where there was apparently no musical ability, and where the child himself was supposed to be utterly deficient in music. The student of heredity, I fear, would unhesitatingly have set down such a child as non-musical because of failure to inherit the prerequisites. Yet this child, after being educated in a natural manner, has acquired Positive Pitch, has learned to compose, to express his own feelings musically, and to analyze compositions which would baffle many teachers.

Thus, although a child may come from a supposedly unmusical family, it by no means follows that the child cannot develop musical ability of a high order. On the other hand, what of the cases where the child of two musical parents fails to show talent?

I have in mind one striking case of this sort which I met years ago. The father was a pianist of international renown, the mother a gifted musician. They hoped, of course, that their child, with its double inheritance, would surpass either one of them: they confidently expected such a result. The child was set to studying music at an early age, but made no progress whatever; he was declared to be dull, uninterested, hopeless.

I was naturally curious to find the reason for this state of affairs: and they were not hard to find. Almost the first inquiry I made disclosed the fact that the child showed a dislike for tedious hours of practicing, and was therefore frequently shut up in a dark closet for an hour or two at a time, to instil in him a greater love for his lessons, and a spirit more obedient to the wishes of his parents. Small wonder that he lost interest in music; and without interest, without an eagerness to learn, little can be done. But where the interest and will exist, it is an unusually defective child that cannot acquire a considerable amount of musical ability; and the same to a less extent holds good of adults.[1] Perhaps it may be of interest if I explain in a little detail the views on this point to which twenty years of teaching have brought me.

If the motive for studying music be made clear and the method of teaching be sound, we may count confidently on the results. Browning says, "It is better Youth should strive, through acts uncouth, towards making, than

---

[1] This view has been developed of late years by a number of psychologists. In the Archiv für die gesamte Psychologie, XXXIV, 12, pp. 235–253 (Leipzig, 1915), Siegfried Bernfeld of Vienna cites two university students whom he studied, each of whom was supposed to be utterly unmusical, until the exertion of the will, as he says, led to the development of considerable enjoyment of music. He concludes: "The individual's reaction to music is by no means wholly decided by the nature and quantity of his psychophysical tendencies. It is influenced to a certain degree by the will to be or not to be musical . . . Even when accurate tests have shown that a person possesses all the elements of musical ability, it cannot be foretold with certainty whether he can acquire musical appreciation, for it is possible that an inhibition with retroactive force against music may exist in him, a will to be unmusical, or at least to seem so to himself and others." Cf. also Sterne, die differentielle Psychologie (1911), p. 265. For the opposite view, that heredity is the primary factor, consult Hans Rupp, Ueber die Prüfung musikalischen Fähigkeiten; Ztschft. f. die angewandte Psychol., IX, Nos. 1 and 2; also C. B. Davenport, Heredity in Relation to Eugenics (New York, 1911), p. 48. The psychological literature on music is large; for an interesting account of how musical ability is measured see Carl Emil Seashore, Psychology in Daily Life (New York, 1913), pp. 196 ff.—The Editor.

**COMPOSITION OF A 13-YEAR-OLD BOY**

Acting on the principle that music is as natural a form of self-expression as are words, Mrs. Fletcher-Copp tries to get children to express their feelings in this way. The above composition represents the thought of a 13-year old boy after studying a picture called "The Last Outpost," in which an Indian who has been driven from the ancestral hunting-ground of his tribe contemplates the waters of the Pacific with the thought that if he is again forced by the white man to move, it can only be into the ocean. (Fig. 7.)

repose on aught found made." We have made the mistake in music teaching in the past of putting the finished product of another's mind before our children and forcing them to copy it. Behind this mistake is the wrong motive. The main idea was to force the child to copy, parrot-like, at the earliest possible moment, the thoughts of some one else. Music was looked upon merely as a means of adornment, as something to be plastered on the outside to add to the attractiveness of the child. The motive is altogether wrong. Not slavery to someone else's ideas but freedom to express one's own ideas should be the aim. Watch a tiny child seated on his mother's knee. She has been playing and he has been told to keep his little paddies on her wrists, but presently he pushes her hands aside and substitutes for the beautiful composition his own incoherent pattings and poundings of the keys, striving "through sounds uncouth" to express himself; but, alas! he is stopped. It is as though a two-year-old should toddle to his mother and stammer with his crooked little tongue, "See, mama, ve sun is playing hide and go seek wif me," and the mother should say, "You must not talk that way, my child. You should say, as Homer writes, 'Lo! Dawn the rosy-fingered, opes wide the gates of Day.'" What would be the effect of this classical method of teaching English upon one's joy and proficiency in acquiring the mother tongue?

### METHODS OF EDUCATION

The motive, then, for learning musical notation must be for the purpose of freeing the child by giving him the means of expressing his own ideas on paper as well as giving him pleasure in reading easily and joyfully the thoughts of others. The means used for the attainment of these ends are most important. They must cultivate as many of the child's senses as possible. If he can feel the symbols as well as see them; if he may see them in a big, tangible form; then through this touch contact and through this ready sight, it

occurs to him to place the symbols thus and so and then to find out on the piano what the symbols so placed by himself will express when sounded.

We, therefore, give the child notes of heroic size to play with and a loose-noted key board to take to pieces and become familiar with by putting together again. We have further invented games which call into play qualities of mind the lack of which has wrecked many a musician in the past; games which cultivate the ability to think calmly, coherently and quickly before others, games which require rapidity of thought and action and which develop unselfishness, generosity and balance, mental, emotional and technical. It was not music which made for the lack of these qualities as has often been insinuated; it was a lack of the most valuable traits of a true musician, missed by acquiring a certain musical veneer without real, scientific, educational growth.

In the past to be a musician was almost a synonym for being characterized by nervousness, lack of balance, general peculiarity and uselessness in practical life; but, to repeat, these deficiencies were not because of music but rather proved a lack of musical development in its entirety.

If we will consider music as a language, not so much of the intellect, as of that finer, higher, more spiritual part of us, a language which this soul of ours needs; and if we will then consider all the sensible things we do to acquire other languages and try these same things for the attainment of the musical language, we may make some interesting discoveries. When a 5-year-old child speaks English it is because he has thought it and has his own thoughts to express. First in music, then, a child should be led to think his own music, to speak his own music before he is taught to copy. He cannot become an independent thinker by first being wholely and solely a copyist. Improvising and modulation in music are equivalent in English to power to express the sense contained in a prose paragraph or in a verse. It is like taking six adjectives, three nouns, two verbs, and three prepositions and making a sentence out of them. These rudimentary exercises in English lead to more or less freedom in the art of expression of ideas if we have any to express later on. We do not say at the outset that there is no earthly use in having the child participate in such and such exercises because he will never be an author; the being an author is submerged in the practical usefulness of self-expression. Precisely the same attitude should be taken in regard to music if it is to be allowed to do the good and be the good to us that it may be. When we take an idea from a poem or an essay and express it in our own words, we are improvising in English. Are we never to do this in music? Can we get nothing except the literal thought word for word as we read it?

### THE VALUE OF MUSIC

The value of learning music is not in the number of pieces one may play, but in the musical thoughts one can think. Real music is self-expression and, far from making the child self-centered, it should make him most sympathetic of the efforts of others. A child who has made his own Reverie or dream has the keenest appreciation of a "real composer." We know that to trim a hat does not cause one to be unappreciative, but the reverse, of a well-trimmed hat. So it is with cake-making, dress-making, story-making, poem- and music-making. We do not complain because so few of the boys and girls, who during their school days wrote essays on "The Dog," "Our Country's Flag" or "A Visit to Grandmother," fail to become authors or authoresses. We are satisfied if they are able to express themselves well in spoken or written language as required by the demands of every-day life. But there are times when every human being feels the need of a language beyond the power of words. Plato said, "Music is to the mind what air is to the body." Now air is a necessity but we moderns have not believed music to be a necessity. We have considered it merely an accomplishment. How much more it might be! Just the other day a boy of 13 brought to me the little composition which is reproduced in Fig. 7. He had

seen the picture weeks before of a lonely Indian standing against the sunset sky, gazing in calm desperation into the ocean at his feet. This would be the next move if he were ordered further west. The picture was called "The Last Outpost" and it stirred up feelings in the boy's heart which presently got out on paper (much the safest, healthiest place for them) in the form of this little composition. This is only one example of oh, so many natural outbursts of feeling in music.

Every human being feels at some time or other the need of music, but this music which he needs is not the artificial substitute which has usurped the place of the real thing. Music can be to each only what he is capable of hearing, feeling and understanding. Therefore when one sits at the piano and plays a Beethoven Sonata which one cannot think, cannot analyze, cannot mentally hear—plays exactly in the manner of the Herr Professor—one is exemplifying the parrot in music and this is an unsatisfactory accepting of the unreal for the real, which gets us nowhere. Man is not the sum total of his words but of his thoughts and it behooves us to stop copying words, words, words in music and to begin to think and to express ourselves.

When we really believe what we say, that "nothing is too good for the American child," we shall give him eight years' training in the public school in self-expression in music and the results will prove beyond cavil the source and cause and meaning of music. They will also, I am sure, leave no ground for the belief now entertained by some geneticists, that musical ability is a rare "unit character" due, as has been alleged, to some "defect in the protoplasm" which only a few families possess; they will show on a large scale what my own experience has already made clear to me, that musical ability is part of the universal inheritance of man, just as the ability to talk is, and that the differences between individuals in respect to it are due much more to training than to differences in the heredity.

## Official Register of Selected Plants in Hungary

The Hungarian Minister of Agriculture has accepted the scheme proposed by Emile Grabner in his report presented in 1913 to the Royal Institute of Plant Breeding ot Magyarovár and has issued an order regarding an official register of selected plants in Hungary. On the basis of this regulation, the State recognition and official registration of selected Hungarian plants came into force, on September 1, 1915. The Royal Institute of Plant Breeding is responsible for the keeping of the official register. The effect of this provision will be to give an additional impetus to plant breeding which of latter years has already made such rapid strides in Hungary. On the one hand it will protect Hungarian growers from the adulteration of seeds and the false description of inferior seeds, and on the other hand, it will afford a safe guarantee to the purchasers of the strict selection of the species the seed of which they wish to acquire.

At the same time, the Minister of Agriculture has authorized the said Institute to present, as soon as possible, detailed schemes regarding the development, on a large scale, of the intensive selection of Hungarian plants. The Minister considers it desirable that the work of selection should not be left merely to a few enthusiasts but should be taken up in a methodical manner by all practical agriculturists, with the close collaboration of the said Institute.—*Bulletin of International Institute of Agriculture, Rome.*

## Crossing Apricots and Peaches with Cherries

The wild Compass cherry has been crossed with the apricot and the peach, at the Minnesota state fruit-breeding farm. A number of seedlings have been secured but have not yet fruited. The cherry was used as the mother parent, and the hybrids resemble the pollen-bearing parent strongly in every instance, according to Supt. Charles Haralson.

# A BOTANICAL PARADOX

D. F. HIGGINS, *Pekin, China*

CHINA is supposed to be the home of many strange things, among which those of the vegetable kingdom are not the least. There are giant persimmons, to four inches in diameter, and better to eat than Americans can imagine, for all the "pucker" is gone before they are ripe; and there are full-grown pine trees not over two feet high. Lilliputian lemon trees grow in one's parlor and bear fruit ready to be picked for the fish when it is served in the dining-room The Chinese farmer is a pastmaster, in an empirical way, of the arts of budding and grafting. The "English" walnut is indigenous to China.

One day I made a visit to the Great Bell Temple, a few miles northwest of the city of Peking, and there I found a botanical wonder which outdid all that I have ever seen or heard about. In grafting, it is generally thought that the species must not be far removed from each other; but here I found a specific gap of a botanical phylum, and an evolutionary gap of geologic periods of time, covered, I was assured, not by human means, but by nature's accidents.

In the court of this temple is a pine tree (*Pinus sinensis*) from the side of the trunk of which, at about 8 feet above the ground, is growing a healthy elm tree (*Ulmus pumila*) about 1 foot in diameter. The junction is shown in detail in the accompanying photograph. Around the junction there is no sign of any break in the bark of the pine tree.

Here is a problem for plant chemists. Can the food solutions of the gymnosperms be utilized by an angiosperm? and I would ask the students of genetics: Can the "sport" form of variation, so often credited with the origin of new species, extend to such a violent disruption of nature's continuity as this? Or, did one elm seed, of the millions which have doubtless lodged in the crevices of pine tree bark, so sprout and take root that, through inherited or environmental advantages, it was able to assimilate the nutritive substances of the pine? Or has Chinese arboriculture surpassed itself, and performed this union which almost staggers reason?

This is truly a very wonderful thing, but this is not all. In the crotch of the pine, some 18 feet above the ground is still another deciduous angiosperm growing from the same pine tree! This tree is a paper-mulberry (*Broussonetia papyrifera.*) At the time of these observations, in the spring of 1915, it was about 2 inches in diameter, and growing lustily. The fruits, somewhat like sycamore balls, were about half grown.

It would be interesting to know if definitely recorded instances of such growths as these are to be found elsewhere. (Note—Unless there is definite evidence to the contrary, it would be much easier to believe that the pine tree is partly hollow, and that the elm and paper-mulberry have sent their roots down into earth and decaying matter in the hollow trunk.—The Editor.)

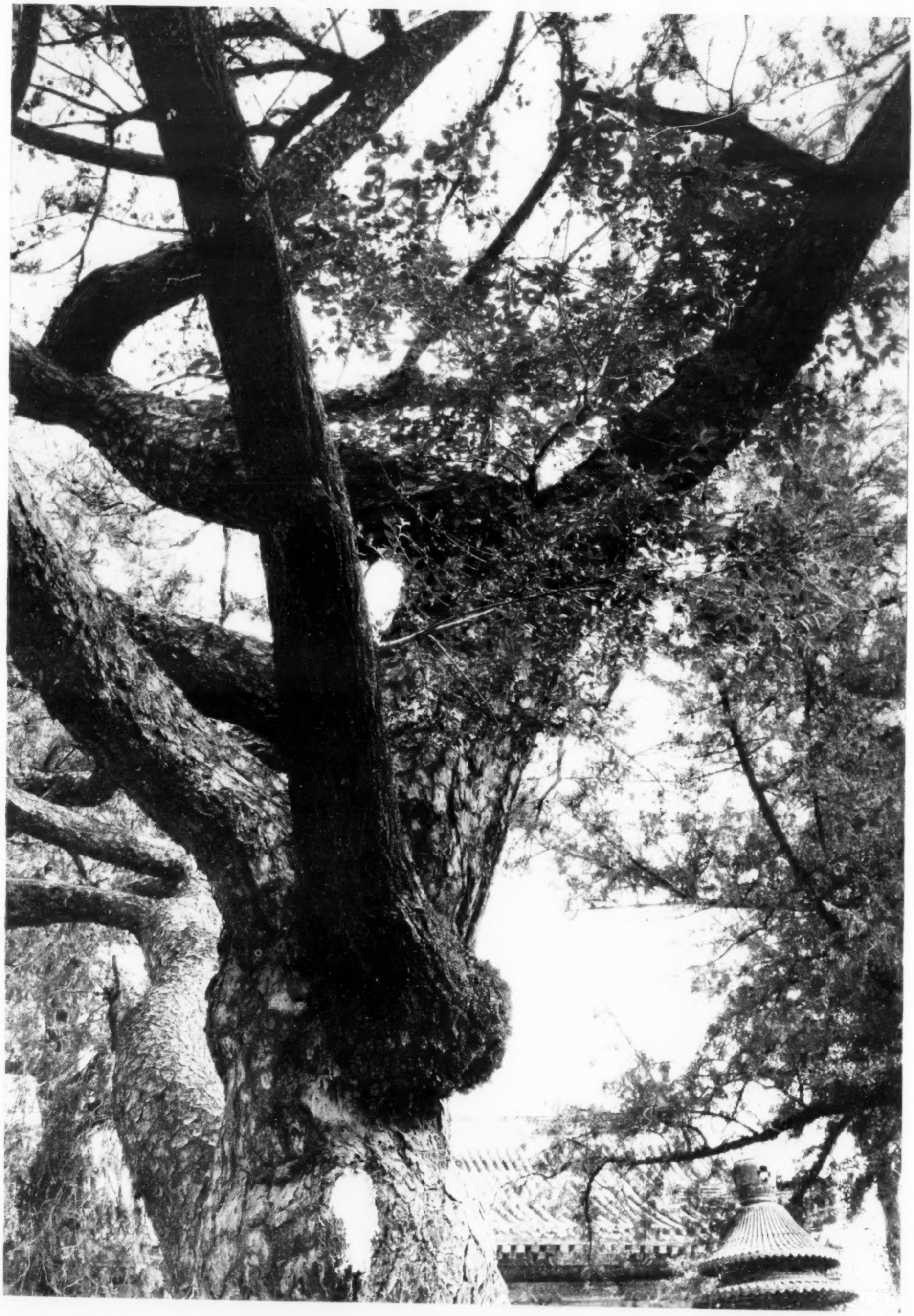
---

## The A. G. A. and the A. A. A. S.

The American Genetic Association, being affiliated with the American Association for the Advancement of Science, is entitled to have two representatives on the council of the latter organization. Prof. Albert F. Blakeslee of the Carnegie Institution, Cold Spring Harbor, Long Island, N. Y., and Prof. Edward N. Wentworth of the Kansas State Agricultural College have been appointed to act in this capacity. The next meeting of the American Genetic Association will be held in New York City, December 26–30, in connection with the meeting of the A. A. A. S.

**THE STRANGE GUESTS OF A PINE TREE**

In the court of the Great Bell Temple, a few miles from Pekin, stands this Chinese pine from which are growing two deciduous trees which are about as little related to the pine as any trees could be. One, to which the man is pointing, is an elm; the other not plainly visible in this photograph, but to be seen more clearly in Fig. 9, is a paper-mulberry. The Chinese are pastmasters in horticulture, but it is impossible to believe that they could graft such diverse species as these. The botanist might have abundant faith to believe that the lion and lamb will lie down together, but, unless he had seen it, he would probably be unable to believe the story which this picture tells. Photograph by D. F. Higgins. (Fig. 8.)



**AN INCOMPATIBLE HOUSEHOLD**

Near view of an elm growing from the trunk of a pine. In the crotch of the pine, above the elm, may be seen the small black trunk of still another tree—a paper-mulberry, the foliage of which occupies much of the upper right-hand part of the photograph. The elm and paper-mulberry are so different from the pine that it is hardly believable that they could live on its sap, but it may be that the trunk of the pine is partly holiow and contains earth and decaying matter which furnish nourishment for the strangers lodging on it. Photograph by D. F. Higgins. (Fig. 9.)

# LET'S POSITIVIZE OUR NEGATIVE EUGENICS

A. E. Hamilton, *New York, N. Y.*

IF WE are going to get the moral support of the people for programs of segregating and colonizing our hereditary defectives in a really large way, we will have to present a program that is alive with the spirit of "something to do." Merely caging people who are a nuisance doesn't arouse much genuine human interest, or at best this interest is academic. But tell a man that you can take a lot of human damaged goods and make it into a useful constructive factor in our national life, and he will sit up and listen.

Charles Bernstein, Superintendent of the Rome State Custodial Asylum, at Rome, New York, has given negative eugenics a golden text that shines.

He turned twenty-five of his higher grade inmate boys into Boy Scouts (all of them passed the tenderfoot requirements), uniformed them and sent them up into the Adirondacks for a month of summer camping last October. He asked Governor Whitman if these boys couldn't be used in reforesting work. They had plenty of time, they loved to work out-of-doors, they were well superintended by George Kuehn, a nature-loving Scout Master who could get that gang of state wards to do anything within reach of their possibilities, and do it happily and well. Governor Whitman was willing, but some small-minded political parasites found a technical objection to State employment of such labor and threw sand in the bearings of the enterprise. But Bernstein persisted.

The boys were sent up to camp, and incidentally a carload of seedling spruce

**THIS BARE HILL WILL BECOME A FOREST**

And the change will be due to a bunch of boys who now represent only waste human material, in most places. The feebleminded are not able to compete on equal terms with the normal, in the struggle of the world's work, but they are abundantly able to do many kinds of work, and do it well, if they have proper direction. They might be made an asset of the State, instead of the liability they are at present, if more people had a sympathetic understanding of their possibilities. (Fig. 10.)

**DO THESE BOYS LOOK DANGEROUS?**

Popular ignorance tends to confuse the feebleminded with the insane and imagine that they should be caged in the interests of public safety. As a fact, most of them are strong, healthy individuals who are, mentally, merely good-natured, irresponsible children. They require careful supervision, but given that they may live not only happy but productive lives. The campaign for "negative eugenics" should be devoted to putting the defectives not only where they can do no harm but even more to putting them where they can do good. The conservation team here shown is made up from boys at the Rome State Custodial Asylum, N. Y. (Fig. 11.)

was left on a siding of the railroad nearby. The door of this car was open, and boys will be boys. Two by two they carried off the young trees, and planted them over a space of some one hundred and fifty acres. They did the work admirably, so well indeed that the State Commissioner of Conservation commended it warmly, and said it ranked as high as any work done by regular paid labor. Just one hundred and fifty thousand trees were set out, all in a spirit of fun and play. The keep of these boys as state wards, plus the cost of transportation, amounted to $400. The net value to the State of the work they did was $1,000 and in twenty years time there will be a broad green monument to the boys' memory.

There are hundreds of thousands of acres of national land that need reforesting and conservation work. There are several hundred thousand unfortunate young men and boys who cannot compete favorably with their fellows in the world who could do this work if they were rightly directed. Camp colonies in summer, transportation southward in cold weather for work down there, institutional housing in winter where necessary—all these things are coming, and they will come all the more quickly as people are told such stories as this, and stories such as Alexander Johnson, of Vineland, can tell by the ream of the possibilities that lie in subnormal nervous systems.

Eugenics will make progress just about in proportion as it eliminates its emphasis on pathology and concentrates on the positive aspects of human possibility.

# HYBRID TREES

## Many Natural Hybrids, as Well as Sports, to Be Found—Artificial Hybridization Leads to Production of Trees Valuable for Their Great Vigor—What Has Been Done and What May Be Done

A Review by W. H. Lamb

*United States Forest Service, Washington, D. C.*

BREEDING short-lived plants and orchard trees is now a well-established art, but breeding timber trees has hardly been undertaken. The importance of such work is being recognized, however, and Prof. Augustine Henry has made a notable contribution in his study of natural and artificial hybrids.[1] His recent paper on the black poplars[2] offers some excellent examples of the occurrence of natural hybrids and the value of artificial ones.

The cultivated species of Populus which have been found desirable for commercial plantings, he points out, are without exception of "unnatural" origin, in that they are either sports or hybrids, and not ordinary species.

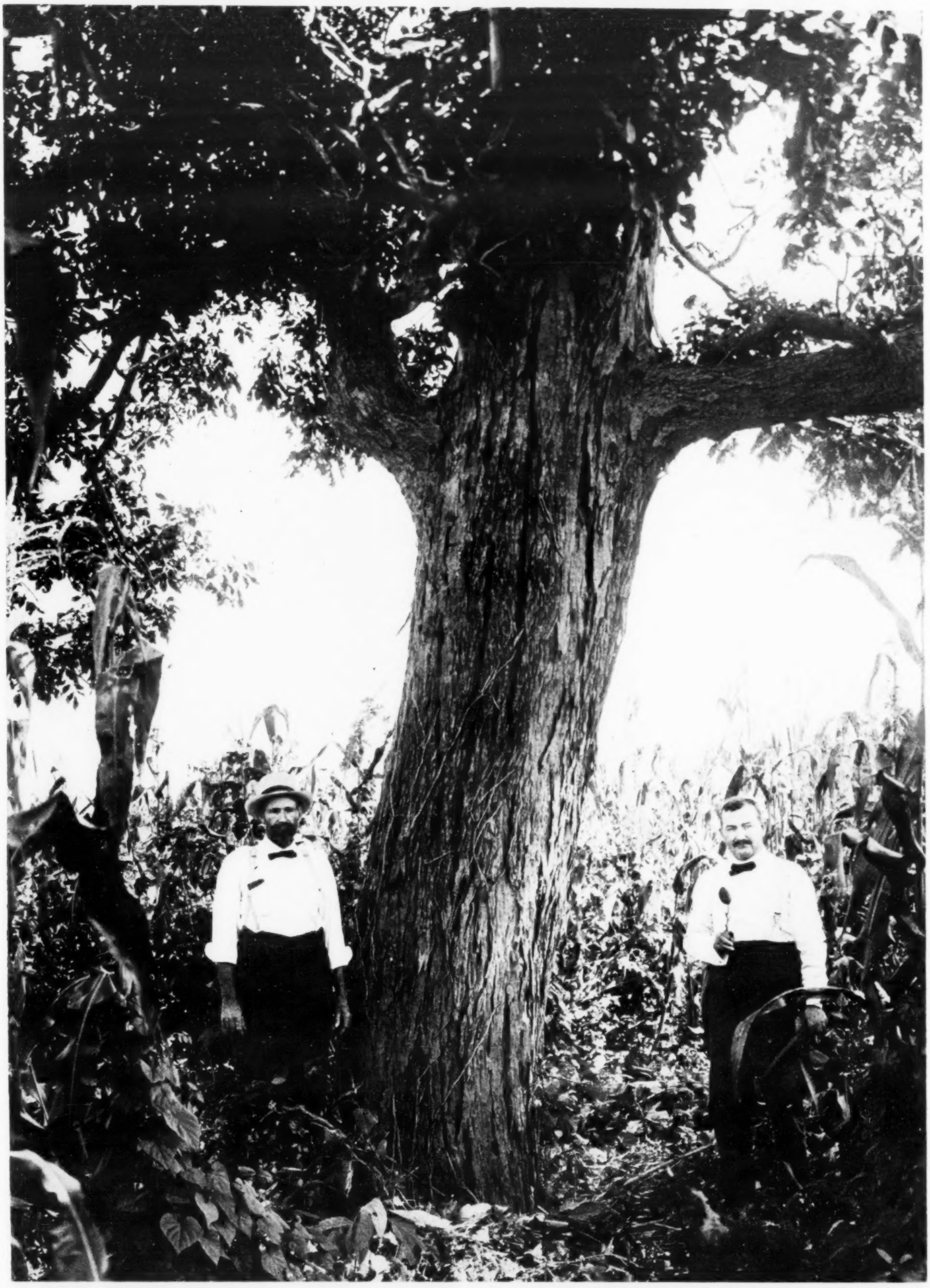
"A sport is usually a solitary phenomenon, arising either as a sporadic peculiar seedling from a seed, or developing out of a bud on a tree as a single branch with some peculiarity of twig or leaf. A sport may be looked upon as a freak, not forming the starting-point of a new species, but speedily becoming extinct if left to nature. Sports, when of interest on account of the curiosity or the beauty of their appearance, are propagated usually by grafts, cuttings, or layers; being only in rare cases perpetuated by seed. Some sports are due to arrested development. The tree, in the course of its life, often passes through stages, like those of an insect. The seedling of many species differs from the adult tree as a larva from a butterfly. The infant ash has simple leaves. The sport known as the simple-leaf ash is simply a seedling ash, which has never progressed to maturity and may be called a persistent larval form. The Irish yew was found in 1767 as a seedling on the mountain behind Florence Court in Fermanagh, and is characterised by all the branches being directed vertically upwards and all the leaves spreading radially around the twig. This is apparently also the seedling stage preserved. All the myriads of Irish yews, now scattered throughout the world, are cuttings either from the original tree at Florence Court or from trees that were derived from those cuttings.

### THE LOMBARDY POPLAR

"This upright, so-called fastigiate form may occur as a sport in any species, the best known being the Lombardy poplar, which originated on the banks of the Po about 1700 and subsequently spread over the world. The Lombardy poplar and Irish yew are striking examples of the immense number of individual trees of a sport that may exist, this abundance being entirely due to human agency. Left to nature, these two remarkable forms would never have multiplied, and would have ceased to exist, once the original trees had succumbed to old age or injury. The fastigiate sport is of rare occurrence in most genera, usually only a single original tree being recorded. Amongst, however, the cypress and juniper families, fastigiate seedlings are

[1] Henry, Augustine, "The Artificial Production of Vigorous Trees," *Jour. of Dept. of Agric. and Tech. Instr. for Ireland*, XV, 1, 1915. Reviewed by W. H. Lamb in *Proc. Soc. Am. Foresters*, X, 2, April, 1915.

[2] Henry, Augustine, "The Black Poplars." *Trans. Royal Scot. Arboricult. Soc.*, pp. 14–27, January, 1916; also in *Gard. Chron.* (London), LVI, pp. 1, 46, 66, July, 1914.



**A NATURAL HICKORY HYBRID**

This tree, which is believed to be a cross between the pecan (*Hicoria pecan*) and the shellbark hickory (*H. laciniosa*) is standing in a rich river bottom 12 miles from Mt. Vernon, Ind. Like most first-generation hybrids, it is a vigorous and rapid grower, but perhaps for this very reason its leaves and branches are tender and succulent—at any rate it seems to attract all the insect pests in the neighborhood. This is not always the case with hybrid trees, however, for many of them are superior to their parents. The immense size of the nuts which this hybrid bears can be judged from one which the man at the right of the picture holds in his hand; in Fig. 15 a single one of them is shown natural size. Photograph from the United States Department of Agriculture. (Fig. 12.)

common; and the upright habit appears to come true from seed. The Mediterranean cypress has been known in this peculiar narrow form for centuries, but always cultivated. In the wild state, as in the mountains of Cyprus, the tree is widespreading in habit. The common juniper, however, is often fastigiate in the wild forests of Scandinavia. This exemplifies the difficulty of strict definition in nature, as the fastigiate habit, which is a rare sport in most trees, becomes in the junipers and cypresses almost a normal form, capable of being perpetuated by seed."

If sports among forest trees are more common than has been generally supposed, the same is true of hybrids. Prof. Henry mentions the hollies of Great Britain, which include numerous hybrids and sports, as well as good species. American naturalists are familiar with the hawthorns, whose hybridity has lately been demonstrated by Prof. E. C. Jeffrey of Harvard and his pupils.[3] The extraordinary state of affairs in the hawthorn genus (Crataegus) may best be realized if we recall that more than 700 alleged species of Crataegus have been described, whereas, of all other trees in the United States put together, there are only some 600 species.

### HYBRID OAKS

The willows are known to hybridize widely, and the various species of oaks readily cross with any of their near relatives that happen to be growing near. Prof. Henry cites an interesting oak hybrid in England:

"The results of the experimental sowings of the seeds of numerous elms which I made in 1909, together with an investigation into the history of the Lucombe oak, given in a paper read by me at the Linnean Society on the seventh of April, 1910, threw new light on many hybrid trees in cultivation, which had not previously been recognized as such, in spite of the fact that no one could find these trees anywhere in the wild state. The statement often made that a particular tree was a 'variety of garden origin' was no explanation. The Lucombe oak was observed in the Exeter Nursery in 1765 as a seedling, which differed from its parent, a Turkey oak (*Quercus cerris*), in being much more fast in growth and in retaining its leaves during winter till March. Lucombe propagated this seedling by grafting, and believed it to be simply a sport of the Turkey oak. In 1792 it bore acorns from which numerous seedlings were raised, no two of which were alike, while some strongly resembled in bark and leaves the Cork oak (*Q. suber*). Lucombe's son then correctly surmised that it was a hybrid—the flower on the Turkey oak, from which the acorn producing it was formed, having been fertilized by the pollen of an adjoining large Cork oak.

"This case illustrates several well-known laws in regard to hybrids:

"1. The first cross is usually of exceptional vigor, more vigorous than either parent.

"2. When the first-cross reproduces itself by seed, the second generation consists of classes of individuals, which differ from one another and from their parent. The first-cross never comes true from seed, but produces a mixed and varied offspring.

"3. None of the individuals of the second generation equal in vigor the first-cross. This was also clearly established in the case of the Lucombe oak.

"Other common trees, of which no history is recorded, doubtless originated in the same way as the Lucombe oak, namely, as chance seedlings (the result of accidental crossing by wind or an insect), which observant nurserymen or gardeners found desirable to propagate on account of their vigor. The introduction in quantity into Europe during the seventeenth century of North American trees, which grew alongside similar but distinct European species in parks and gardens, was the occasion of considerable hybridization. Trees like the black Italian poplar and the London plane, which have nowhere been seen wild, are intermediate in botanical characters between an American and a

[3] Standish, L. M. What is Happening to the Hawthorns? JOURNAL OF HEREDITY, VII. 6, pp. 266–279, June, 1916.

European species in each case, and are undoubtedly first-crosses. These two trees have been traced back to 1700, about which date the American parents had been long enough in Europe to bear flowers."

### THE POPLAR HYBRIDS

The black poplars, it will be remembered, are represented by only two species, one native to Europe and the other to North America, and both having well-marked geographical varieties. The European species, *Populus nigra*, is distinguished from the American tree, *Populus deltoidea*, by the absence of cilia (tiny projecting hairs) on the margins of the leaves, and by the absence of glands on the base of the leaf-blades in front. These characteristics are present on the leaves of the American black poplar. The author designates the glabrous form of the European black poplar as *Populus nigra* var. *typica*, and the pubescent form as *Populus nigra* var. *betulifolia*. The glabrous black poplars of North America are given as *Populus deltoidea* var. *monolifera*, growing from Ontario to Pennsylvania, and *Populus deltoidea* var. *occidentalis*, growing in the region directly east of the Rocky Mountains, from Saskatchewan and Alberta to New Mexico and western Texas. The pubescent American black poplar is *Populus deltoidea* var. *missouriensis*, which grows in the south and southeastern parts of the United States, ascending the Mississippi basin to Missouri. This variety, the author believes, may be taken as the type of *Populus deltoidea*, being most likely to be the form represented by the original description of Marshall.

### THE CAROLINA POPLAR

But the chief importance of Prof. Henry's contribution lies in his extensive study of the cultivated black poplars, which has resulted in the valuable discovery that they are almost invariably of hybrid origin. Most interesting to American foresters is the discovery made concerning the Carolina poplar which has been so extensively cultivated here. A great many of our writers have felt that this name, "Carolina poplar," was one invented by nurserymen to overcome the unpopularity of the cottonwood. Some have even believed that the *Populus nigra* of the trade was nothing but our *Populus deltoidea* grown in France and Belgium and returned to America under the false designation. Much relief, therefore, will be experienced by reputable dealers, and by their patrons as well, at having Prof. Henry's determination of the true nature of the cultivated black poplars, and especially the Carolina poplar. Originally the author felt that this tree was merely a form of our *Populus deltoidea*, which had undergone mutation in its floral parts after cultivation in Europe. But now it is determined that the tree is a hybrid between the true black poplar of Europe (*Populus nigra*) and the southern form of our native black poplar (*Populus deltoidea* var. *missouriensis*).

In addition to the Carolina poplar, a number of hybrids are illustrated and described by Prof. Henry which have been derived from the typical black poplar of Europe and the northern form of our black poplar (*Populus deltoidea* var. *monolifera*). These are: *P. serotina* Hartig, *P. regenerata* Schneider, *P. Eugenei* Simon-Louis, *P. marilandica* Bosc., and *P. Henryana* Dode. Further, two forms are described as having arisen from the hybridization of the European black poplar with hybrid forms. These are *P. robusta* Schneider and *P. Lloydii* Henry.

### WHY NOT A HYBRID SYCAMORE?

Viewing this work in the light of the previous researches of Prof. Henry on the artificial production of vigorous trees, it will be observed that the author has first demonstrated the practical importance of propagating first generation hybrids. He has then ascertained that the poplars already recognized as especially desirable for cultivation are of hybrid origin. The two papers, therefore, present most forcibly the great importance of initiating intensive work on the artificial production of vigorous trees, and suggest that special attention be directed toward the hybrid-

**A CLUSTER OF PECAN NUTS**

The pecan is a species of hickory and its nuts, here shown natural size, are enclosed in pods or husks. It is becoming an important crop in the southern states, due to the isolation and propagation of superior varieties instead of dependence on mixed seedlings, as in the past. Photograph from the United States Department of Agriculture. (Fig. 13.)

ization of species of many genera. Our sycamore, *Platanus occidentalis*, for example, is one of the most rapid growing of our hardwood trees. But it is afflicted with a fungus disease which causes the leaves to fall almost immediately after they have appeared in the spring. The restored foliage does not appear to suffer, however, and the tree does not appear to be greatly retarded in its annual growth, for notwithstanding this infirmity, the tree holds first place in size among North American hardwoods.[4] But the tree is being replaced by the European sycamore or plane (*Platanus orientalis*) in street and landscape plantings, as the exotic species appears to be immune to this disease.

[4] Lamb, W. H., in JOURNAL OF HEREDITY, VI, 9, pp. 424–428, September, 1915.

The possibility of producing a vigorous hybrid between these trees is immediately suggested. In fact one may already exist. The London plane, *Platanus acerifolia*, has never been found growing wild and exhibits characteristics intermediate between the American and the European planes. But without doubt, it would be highly profitable to experiment with hybrids of known parentage.

A large field for profitable research is thus opened up by the possibility of artificially producing trees having exceptional vigor. The oaks, chestnuts, lindens, and many other important genera offer a fertile field for experimentation. And at the present time the importance of such work can scarcely be overestimated.

How little has been done is made strikingly clear by Prof. Henry's historical review. He ascribes to Klotzsch the credit for the first hybridization, with the production of pine, oak, alder and elm hybrids at Berlin in 1845. The results were good, but the work attracted little attention.

### VIGOROUS WALNUT HYBRIDS

The frequent production of hybrid walnuts in California led Luther Burbank to take up this genus, and he called attention to the valuable qualities of the first-generation hybrids, which grow so rapidly that experienced foresters will scarcely credit the figures. Trees of the so-called Paradox walnut (*Juglans regia*, the Persian or "English" × *J. californica*) at Santa Rosa measure 80 feet in height and 6 feet in girth after fifteen years of growth. The hybrid known as Royal (*J. californica* × *J. nigra*, the black walnut of the eastern United States), appears to be an even more rapid grower, one specimen being credited with a height of 100 feet and a girth of 9 feet after only sixteen years of growth. Another magnificent walnut hybrid is that on the James River, Virginia, which was described by Peter Bisset recently.[5]

As to the quality of the wood of these hybrid trees—a point of prime importance to foresters—Prof. Henry remarks:

"It is a popular belief that fast-grown timber is necessarily soft and comparatively worthless. This is a fact in most conifers; but in one class of broadleaf trees, the wood of which is characterized by large pores in the inner part of the annual ring, the contrary is true, as the faster the timber of these trees is grown the stronger and denser it becomes. This class includes oak, ash, chestnut, hickory, and walnut, the species in fact that *par excellence* produce the most valuable timber.

"All the more reason, then, for efforts to produce fast-growing crosses in the case of these precious trees. To quote from the conclusion of my paper of 1910: 'In countries like our own the only hope of salvation for forestry is in growing timber rapidly; and we have been helped in that by the introduction of fast-growing conifers like the larch, the Corsican pine, and the Douglas fir. But it is essential to grow the more valuable classes of non-coniferous timber.' The difficulty of growing the ordinary species of oak, ash, and walnut is the long period required for their maturity, which renders hopeless, except on the best soils, all chance of an adequate financial return. Without vigorous first-crosses, the most valuable classes of timbers can only be grown in limited quantity."

### THE CAUSE OF VIGOR

Although many geneticists have speculated on the problem, no one has yet been able to offer a satisfactory explanation of the extraordinary vigor displayed by hybrids. Some of the Mendelian hypotheses put forward are plausible, but have so far remained unproven. The observed vigor, as Prof. Henry points out, "is distributed over the whole plant, and is as conspicuous in the roots as in the stem and leaves. What we actually observe is not only an acceleration of, but also an increase of cell-division in all parts of the plant. The cells divide very quickly, continue to divide, and thus build up a taller stem, a more extensive root-system, etc.

[5] Bisset, Peter, "The James River Walnut." Journal of Heredity, V, 3, pp. 98–102, March, 1914.

**NUTS OF THE SHELLBARK HICKORY**

This is one of the commoner hickories of the central United States; its nuts, here shown natural size but without their husks, differ greatly from those of the pecan. The result of a cross between the two species is shown in Fig. 15, the following illustration. (Fig. 14.)

Apparently this alteration in the nature of the division of the cells is not associated with any visible change in their structure. Miss Marshall, who examined for me many sections of the growing points of hybrid poplars and their parent species, could find, as the result of three months' observations, no tangible differences in the size of the cells or nuclei, in the number of the chromosomes, etc.

"It is possible that the stimulus which causes growth (*i. e.*, cell-division) to commence and to continue is some soluble chemical compound or enzyme. The enzyme in the hybrid may be more complex and more effective than the enzymes in the species. Whether the injection of soluble matter obtained from a hybrid into the growing points of one of the parent species would stimulate the latter to increased cell-division, might be worth trying, if the experiment could be carried out.

"Whether the amount of vigor in hybrids is directly associated with the degree of relationship between the individuals which are crossed is a disputable point, but one of practical interest in the selection of parents for crossing experiments. One of my most vigorous hybrids (*Populus generosa*) is derived from two parents so little related that they are placed in two distinct sections of the genus. A cross between two races of the common alder shows considerable vigor, though the parents are so closely allied that they can only be distinguished by the most trivial characters." But whatever the explanation of this vigor may be, no one who has worked with hybrids is likely to question its existence; and that fact is sufficient to make breeding justifiable.

## PROPAGATION

"An important question is the propagation of these vigorous crosses, once they are created. The first-cross does not come true from seed, and it would be a great drawback if we were obliged to wait till the newly made trees bore flowers and fruit. The first-cross, in short, can only be multiplied by vegetative reproduction. This is easy when the trees are readily propagated by cuttings, as in the case of poplars and

willows, or by layers, like the Huntingdon and Belgian elms. We may resort to grafting low on stocks, which should be perhaps seedlings of one or other parent. This method will serve when cuttings and layers are not available. It is evident, that, when a valuable hybrid has been produced, it can be propagated and be put on the market, if necessary, without delay."

A few suggestions on the technique of cross-pollinating trees may be useful to those who want to try the artificial production of vigorous trees. Both

**HYBRID NUT**

Cross between pecan and shellbark hickory, borne by the tree shown in Fig. 12. The nut is natural size, and enclosed in its husk, one side of which has been removed. It is of small value, commercially. Photograph from the United States Department of Agriculture. (Fig. 15.)

male and female flowers should be protected with bags, in order to prevent the possibility of a mix-up in heredity through the presence of foreign pollen. The male flowers should be bagged a week before they shed their pollen, while the female flowers may be protected for a fortnight before the stigmas are receptive and a week after the cross-pollination has been made. If the tree with which one is working has perfect flowers and is to be used as the seed-bearing parent, the pollen-bearing organs must of course be removed at an early stage, with a needle-pointed forceps. This operation is a delicate one, particularly if it must be carried out at the top of a lofty tree, swaying in the wind. Sometimes it may not be necessary, if the flowers are protected by nature from self-pollination. In the case of the ash and elm, for example, the stigmas are receptive some days before the anthers shed their pollen. Under these circumstances, the pollen from another species may be applied to the stigma, and no attention paid to the anthers.

### HANDLING TREE POLLEN

"Pollen spoils by keeping, but it often must be kept for some time till the stigma of the female parent is receptive. It is often obtained from distant countries where trees of the desired species, flowering early, can be found. It is best kept in a small glass tube either corked or plugged with cotton wool. Pollen is usually collected by cutting off the flowering twigs and placing them on white paper in a dry place for one or two days.

"Pollen is applied with a camel's hair brush, and a minute quantity is sufficient for each stigma. The stigmas are to be pollinated when receptive, indicated by the presence on them of a sugary solution or by their change to a brighter hue. Pollen grains may not be able to germinate on the stigma of another species, and yet be capable of fertilizing it, if germination could be induced. The transference of a drop of the substance secreted by the stigma of the pollen-bearing species to the stigma of the other parent might induce germination. The best time for pollination is in the warm part of the day, between 11 a. m. and 3 p. m. in early spring. Cold, wet days should be avoided."

It is not a very long time, in the history of the world, since the English gardener Fairchild produced the first

artificial hybrid plant on record, in 1715, by fertilizing the stigma of a carnation with the pollen of a Sweet William. Since then, the process of artificial cross-pollination has transformed commercial horticulture and agriculture. There is good reason to believe that it will find an equally widespread application in forestry, and it is probable that Europe will undertake the work rather than the United States. The American continent still contains a large supply of virgin forest. Many years ago, however, the European forests passed the virgin stage and became the objects of thorough silvicultural management. They became an agricultural crop. Even in normal times the planted timber is recognized as entirely inadequate for the domestic requirements, but the present war has placed a responsibility upon the European forester greater than can possibly be appreciated. Timber reconnaissance, after the close of the war, will reveal an awful destruction of forest growth. Never before in the history of the world has military activity been so destructive. The great battle wave, extending from Ostend to Belfort, and from Riga to Persia, flows to and fro, while artillery of unprecedented caliber, great jets of liquid fire, and clouds of deadly gases, reduce the forests to desolation. The strategic value of the forests, so often mentioned in official dispatches, but too plainly indicates approaching necessity for intensive reforestation projects, a work which will be so imperative as to render studies on accelerated reforestation of the greatest economic importance. The investigator, therefore, who can produce trees which will exceed the natural species in vigor, will be rendering the most valuable public service. If he can accelerate the reforestation of the battlefields of Belgium and France, he will be rendering a priceless contribution to the national welfare.

## Wanted: A Plant Breeder

There is a possibility of an opening in teaching plant breeding in the Division of Agriculture at the Iowa State College. The candidate should have had some practical experience along plant industry lines, preferably in horticulture. Further information may be had by addressing Professor S. A. Beach, head of the Department of Horticulture and Forestry, Ames, Iowa.

## Eugenics and Military Preparedness

The relations of war to national eugenics have often been pointed out; the eugenic aspects of military preparedness are less often considered. Starting with the axiom that preparation for war should bear in mind the necessity of safeguarding national eugenics as far as possible, we arrive at the following conclusions:

1. A military establishment should be composed of men of as advanced an age as is compatible with military efficiency.

2. It should not be made up of celibates. Short enlistments might be valuable in favoring marriage.

3. Universal conscription would appear to be better than voluntary service, since the latter is highly selective.

4. Officer's families should be given an additional allowance in pay for each child. This would aid in increasing the birth-rate, which appears to be very low among army and navy officers.

5. Means should be worked out to establish men, at the end of enlistment or the end of hostilities, as rapidly as possible economically, so that they may not be forced by economic pressure to refrain from marriage or parenthood.

6. "Preparedness," in the ordinary sense of the word, is highly desirable in order that the loss of men may be minimum, especially during early days of war when, if unready, a nation would probably lose heavily.

These appear to be some of the considerations, which should be regarded in advance of war, if the necessity for defense is to be made as little of a handicap, eugenically, to a nation as possible.

# EXTRA FINGERS AND TOES

THE occasional appearance of one or more fingers or toes in excess of the normal number is technically known as polydactylism, and offers one of the most puzzling problems in heredity. Generally, the mode of inheritance of abnormalities of this sort is fairly plain and follows a simple scheme, but polydactylism has so far baffled all attempts to reduce it to rules; it appears to be almost anarchical.

One of the reasons for this doubtless is that polydactylism may be due to a number of different causes. The guinea-pig may be cited in this connection, for it offers abundant material for study. It ordinarily has three toes, but in 1905 Prof. W. E. Castle of Harvard University found a four-toed specimen which he bred and from which he has succeded in establishing a "four-toe" strain. It has now gone through fifteen or twenty generations, yet the character is not absolutely fixed. Pure-bred four-toes, when mated with their like, will occasionally produce three-toed individuals (which, however, are able to transmit the four-toe character to their offspring), just as pure-bred three-toed individuals when mated together will occasionally, although more rarely, produce a four-toed individual. Prof. Castle describes the heredity of the character as "partly blending, partly segregating;" that is, its inheritance is that of a simple Mendelian character, but one whose visible expression varies greatly. The character is neither dominant nor recessive, he holds, but is directly modified by crosses. "It is quantitatively variable," he writes, "so that by selection one can establish high-grade or low-grade strains of polydactylism, and normals of polydactylous ancestry often transmit the character. It is as good a Mendelian character as many others, but (1) lacks dominance, (2) is variable, and (3) is affected by crosses; *i. e.*, blends to some extent or is contaminated. Strong support for this interpretation is afforded by a recent paper on the inheritance of flowering time in peas (Hoshino, 1915) in which it is shown that the character studied is subject to partial blending but is clearly Mendelian, for it is coupled with the color factor in crosses of red with white varieties."

### MENDELISM IS QUESTIONABLE

A Mendelian character with all the exceptional behavior which Dr. Castle describes is, however, a rather difficult character to follow, and many geneticists prefer to say that polydactylism in guinea-pigs is not yet demonstrated to be a Mendelian character.

The explanation of the appearance of this fourth toe in guinea-pigs is simple: it represents merely a reversion to the ancestral condition. The ancestor of the guinea-pig, in fact, had five toes, and it is therefore likely that a fortunate geneticist will some day find this fifth toe cropping out, and thereby succeed in reestablishing a five-toed strain. Prof. J. A. Detlefsen of the University of Illinois actually found one such animal in his breeding experiments, but it was sterile and could not be used to produce a new race.

Fowls, too, had five-toed ancestors, and although most birds of the present day have only four toes, a fifth toe sometimes appears. It might naturally be supposed that this represented the cropping out of the ancestral character; but Bateson and Davenport have shown that as far as the best known breeds of domestic fowl—the Dorkings and Houdans—are concerned, the fifth toe is not a reversion, but an abnormality due to the splitting of one of the toes (the hallux). How such a race might originate is graphically shown by the accompanying photograph (Fig. 16) of a Racing Homer pigeon, sent in by I. O'Neill Brenan of Brisbane, Queensland. Here it is clearly seen that one of the toes has split, during development, producing a bird with five toes. This bird, bred to one of its own sisters, produced one squab that had an

**A PIGEON WITH FIVE TOES**

As a rule, extra toes are rare in birds, but a few breeds of domestic fowl have regularly five toes. These breeds probably originated in such a bird as the pigeon shown here, the hind toe being split. The split toe is inherited to some extent, and long continued breeding and selection would doubtless result in the establishment of a five-toed breed of pigeons. Photograph from I. O'Neill Brenan, Brisbane, Queensland, Australia. (Fig. 16.)

extra toe on one foot. If sufficient effort were made, probably a strain of five-toed pigeons, corresponding to the five-toed Dorking fowls, could be established on this basis. It would be many generations before all the birds had five toes, but if the five-toed individuals were regularly selected for breeding, it can hardly be doubted that this selection would eventually produce an effect. The relative constancy of the five-toed condition in Dorkings and Houdans, as compared with instability in guinea-pigs is probably due very largely to the fact that the domestic fowls have been stringently selected for five toes.

The five-toed condition in birds is, as has been said, very rare save for the domestic fowl. Geneticists have made numerous crosses of the five-toed breeds with four-toed ones, in order to work out the inheritance of the trait, but they have not met with great success. Professor Castle holds that it is a Mendelian trait and that its irregular behavior goes to prove that Mendelian characters are variable; but most geneticists do not admit that Mendelian characters are variable in this way, and are therefore confronted with considerable difficulty in making the evidence conform to Mendelian expectations. Bateson can only suggest that polydactylism "is perhaps due to a dominant factor which

**LEFT HAND OF ITALIAN IMMIGRANT**

The first joint of the little finger appears to have split in two at a very early stage in the development of the hand, with the result that two little fingers have been produced. This seems to be the way in which extra fingers and toes ordinarily appear in man. In this case the extra fingers are complete in joints and tendons, but often they are much more rudimentary. (Fig. 17.)

**RIGHT HAND OF ITALIAN IMMIGRANT**

The extra finger is almost identical with that of the left hand, shown on the opposite page. Abnormalities of this sort are usually hereditary, although the heredity is frequently irregular. From an X-ray photograph made by the U. S. Public Health Service at Ellis Island, New York, and sent in by assistant surgeon Howard A. Knox. (Fig. 18.)

can be inhibited or suppressed as the result of the presence of other factors. In poultry," he continues, "we know by experiment that the presence of an extra toe may behave as a dominant, following the simple rule with fair regularity, but in other families the number of dominants produced is too small and transmission may occur through normals destitute of extra toes. Such facts point to the existence of some unknown complications in those families."

### POLYDACTYLISM IN MAN

In man it is well known that an extra finger or toe sometimes appears; but as we know of no ancestor, within hundreds of millions of years, who had more than five, human polydactylism can not be like that of the guinea-pig—the appearance of an ancestral character. It may, therefore, most conveniently be assumed to be due to a splitting of one or more of the ordinary digits, which may be so extreme in degree that the individual possesses a "double hand" of 10 fingers attached to one wrist. The most ordinary type consists of the presence of one extra finger, as is shown in the Italian immigrant whose hands were photographed at Ellis Island, N. Y., recently (figs. 17, 18). Dr. Howard A. Knox, assistant surgeon of the U. S. Public Health Service, who sent in these photographs, calls attention to the interesting feature of the case—that the extra fingers function completely, each having fully developed joints and tendons. They seem to have been produced by a division of the little fingers in two.

Dr. Knox investigated the family history of the immigrant as far as was possible, and found that one uncle (probably maternal, but there is doubt on this point) has an extra digit on the right hand only. But its location was the same as that in the subject here shown. The immigrant's second son, about 23 years of age, has one extra digit on each hand and each foot.

Such a family history is fairly typical of most of those which describe polydactylism in man. The condition reappears in almost every generation, but it is frequently not quite the same, and appears to be distributed without regard to any regular form of procedure. Davenport shows this plainly, despite his optimistic expression, when he writes, "The peculiarity of supernumerary fingers and toes is one that is inherited in nearly typical fashion. I have worked extensively on polydactylism in fowls and there can be little doubt that the character behaves the same way in man. The extra toe is due to an additional unit so that when one parent has the extra toe the children will also have it. However, it sometimes happens that the offspring fails to produce the extra toe; but such persons, becoming in turn parents, may produce the polydactyl condition again. . . . The eugenical conclusion is: polydactyl persons will have at least one-half of their children polydactyl. Those quite free from the trait, though of the polydactyl strains, will probably have only normal children."

This conclusion may be a rough approximation to what usually happens, but it cannot be held to be an exact statement of the mode of heredity of polydactylism. Nor is any one in a position at present to give such an exact statement. We can only say that the appearance of extra fingers or toes (they frequently go together) is inherited to a high degree, but without any discoverable regularity. Fortunately, the trait is one that possesses no eugenic significance, and we can therefore view our ignorance with more complacence than if the trait really possessed importance to the race.

---

## Origin of the White Blackberry

The white blackberry put in the trade by Luther Burbank some years ago is a good example of the production of a marketable fruit by the recombination of existing characters. The parents are said to be Lawton's blackberry and an insignificant cultivated bramble of the eastern states. The latter has pale amber berries and is probably an albino variety of the same species of blackberry as Lawton's. Burbank crossed the two and selected from the progeny (presumably in the second generation) individuals that possessed the shape and qualities of the Lawton and the color of the bramble.

# CHANGE OF SEX IN HEMP

## Mutilation Makes Female Plants of Cannabis Sativa Produce Male Flowers—Change in Nutrition Probably Responsible for the Result

FREDERICK J. PRITCHARD

*Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.*

THE possibility of altering normal sex ratios in dioecious species of plants and animals is one of the most debatable topics of genetics. The experimental results thus far recorded are not only varied but occasionally contradictory. When viewed as a whole, however, they seem to indicate that maleness and femaleness are not always fixed characters, but frequently appear more like responses of the developing organism to external stimuli.

Of all the external factors that have been supposed to determine sex, food ranks first. Indeed, many biologists now believe that the determination of sex is in the last analysis a problem of nutrition. It is also remarkable that in nearly every instance in which food affects the sex ratio, favorable nutritive conditions tend to produce females and unfavorable conditions males.

Nevertheless the food theory of sex determination fails to account for the sex ratio of 1:1 commonly found among unisexual individuals.

A Mendelian theory of sex determination now popular not only explains normal sex ratios in dioecious species but receives considerable support from studies of sex-linked inheritance. The fundamental basis of this theory as expressed by a distinguished geneticist is that "sex has its beginning in gametic differentiation and is finally determined beyond recall in the fertilized egg by the nature of the uniting gametes." The hypothesis also carries the assumption that one of the sexes is heterozygous for a sex factor and the other homozygous.

Though subject to criticism, this theory is admirably adapted to the factorial method of analysis and appears to explain many facts of sex inheritance.

The difference of opinion regarding the effect of external stimuli upon sex ratios has led the writer to investigate the following questions: (1) Can sex ratios of dioecious plants be altered by modifying conditions external to their germ cells? (2) Is the alteration thus obtained limited to individuals of one sex? (3) How do the results harmonize with the Mendelian conception of sex determination?

### MATERIAL

As hemp is composed almost wholly of distinctly unisexual individuals it was chosen as a favorable species for the investigation of sex ratios. In addition to its separation of the sexes, it develops in its females a heavy and dense growth of foliage by which they may readily be distinguished from the males. In fact, at the time of flowering the plants may be recognized at a distance as male and female.

The proportion of males to females which normally appeared under the field conditions where the experiments were made was approximately 1:1. Monoecious individuals also appeared in relatively small numbers, as will be subsequently shown, but they were distinctly female in type and preponderatingly female in flower development.

### METHODS

Disturbances of the plant's physiological equilibrium were induced by the removal of flowers and vegetative parts and by the injection of chemical substances into the stem.

In addition to the removal of parts some plants were given further treatment by enclosing their tops in Manila bags to diminish the intensity of the light falling upon the newly developing flower buds.

**MALE AND FEMALE HEMP PLANTS**

At the left is the female or pistillate plant, at the right the staminate or male. In addition to the difference in flowers, the two sexes differ markedly in habit of growth, as is seen. By mutilation, each sex can be induced to take on the characters of the other; a change which may be due to interference with the plant's normal process of nutrition. Photograph by Lyster H. Dewey. (Fig. 19.)

The use of chemicals was limited to the year 1909. To facilitate their introduction small holes were cut into the pith cavities and afterwards closed with paraffin.

In 1914 no leaves or branches were detached but all flowers and flower buds were removed from branches and stem.

The counting of the flowers—a laborious process—was done by fives and tens but this nowise interfered with the observance of the staminate and pistillate character of the flowers.

## EXPERIMENTS

Plants were grown for the investigations at Madison, Wis., in 1909, 1912, 1913 and 1914, but owing to a poor stand in 1912 and the writer's absence in 1913 when the treatments should have been given, the experiments for these two years were not completed. Hence, the results are limited to the two years' investigation in 1909 and 1914.

As no further opportunity has been found to continue the work it seems better to publish the results now obtained than to wait an uncertain period for the accumulation of further data.

In 1909, male and female hemp plants were used in approximately equal numbers. As each plant had at the time of operation already borne a large number of exclusively staminate or exclusively pistillate flowers, any degree of visible monoeciousness could easily have been detected.

The 263 plants treated were mutilated by removing their flowers and flower buds, their leaves, and varying proportions of their stems; the tops of twenty were also bagged; and the stems of sixty others injected with 1 to 2 ounces of one or more of the following chemical solutions: calcium nitrate 1/10%; zinc sulphate 1/10%; dextrose 5%; maltose 5%; peptone 1%; asparagin ½%; potassium iodide 3%; pyridin $\frac{n}{25}$; formic acid $\frac{n}{16000}$; acetic acid $\frac{n}{60}$, $\frac{n}{30}$; sodium hydrate $\frac{n}{300}$, $\frac{n}{100}$, $\frac{n}{60}$.

Alteration of sex occurred under several different treatments. Either covering the top with a Manila bag or injecting into the stem a solution of dextrose, maltose, glucose, asparagin or pyridin was accompanied by a modification of sex. In each instance, however, the removal of parts constituted a part of the treatment. In fact the removal of parts was the only factor common to all the sex-developing responses. Hence it was probably the chief cause of sex alteration.

Of the 163 plants which reproduced flowers after treatment twenty-nine or 17.8% developed some flowers of the opposite sex. Four of these plants were males, the other twenty-five females.

TABLE I.—*Proportion of Monoecious to Dioecious Hemp Plants Found on Successive Dates at Madison, Wis., in* 1909

| Date of examination | Number of dioecious plants | | Number of monoecious plants | Percentage of monoecious plants | Field |
|---|---|---|---|---|---|
| | Male | Female | | | |
| September 23 | 49 | 43 | 8 | 8.0 | A |
| September 27 | 96 | 99 | 5 | 2.5 | B |
| September 30 | 0[1] | 174 | 26 | 6.5(13.0) | A |
| October 1 | 0 | 187 | 13 | 3.25(6.5) | B |
| October 1 | 0 | 84 | 16 | 8.0(16.0)[2] | B |
| October 18 | 0 | 47 | 3 | 3.0(6.0) | B |

[1] As no male plants under these conditions formed perfect flowers, the omission of male plants in the counting records from September 30 to October 18 gives the percentage of monoeciousness for only the female type. The true percentages of monoeciousness are one-half the values inclosed in parentheses as represented by the figures at their left.

[2] Late maturing plants.

It may be argued that temperature or some other factor due to an advancing season was the effective stimulus rather than the removal of parts but this makes little difference as it would still be an external stimulus. The same statement may be made with regard to the possible effects of chemicals and diminished light intensity. However, the percentage of monoeciousness was determined on several successive dates in two neighboring fields designated respectively as A and B. These results are presented in Table I.

The percentage of monoecious plants in field A was much larger than in field B. This may have been due to wider spacing, as the plants in field A stood farther apart than in field B and consequently were larger and better fed; or it may have been caused by some inherent difference in the seed.

If we exclude the records of late maturing plants, made on October 1, the table shows no evidence of an increased percentage of monoeciousness as the season advanced.

The results for 1914 are presented in Table II. As they show unmistakeable evidence of sex alteration from the use of external stimuli they are published in detail. Both the number and character of flowers removed as well as those that subsequently developed are included.

As shown by the table, sex was not altered by bagging the tops but was very decidedly altered by the removal of flowers. Of the fourteen male plants that formed flowers after the operation only three developed pistils but every female plant produced both stamens and pistils in abundance. In fact the proportion of stamen-bearing flowers formed on female plants greatly exceeds that ordinarily formed on monoecious plants.

As a check on the experiments recorded in Table II, twenty-eight female plants were tagged at the time of the foregoing operations and carefully examined at the end ot the season for the appearance of male sex organs but not a single stamen had developed.

It is evident from the experiments and their checks that changes in sex were induced by the removal of flowers and flower buds, probably through alteration of the food supply. The production of pollen and ovules is an exhausting process. As soon as male hemp plants shed their pollen they turn yellow and die. The removal of flowers and flower buds from the female plants when their reserve food is at a minimum probably makes the nutritive conditions less favorable for the development of the new buds and in accordance with the food theory of sex determination, causes an excess of male development. The appearance of pistillate flowers upon a few treated male plants, however, is difficult to explain upon this basis unless we assume that these particular flowers received more than their share of the food supply.

If the effect of flower removal on the food supply has been properly interpreted, it is evident that the proper method of inducing pistillate development in male plants is through high feeding, especially about the time of flower formation. This should be done through the soil in such a way as not to interfere with the plants' normal physiological activities.

## CONCLUSIONS

The foregoing experiments show that sex of hemp is alterable by the removal of flowers. While only a few male plants produced pistils, they constituted 14 to 21% of the total number of males reproducing flowers after the operation. It is quite probable that if the proper stimulus were used pistil formation could be induced in all the males. The females were very responsive to the stimulating effect of flower removal. In fact in the second year's experiments every female operated upon produced an abundance of stamens.

The results do not seem to support the theory that sex is wholly a matter of zygotic constitution—one dose or amount of an inherited sex factor producing one sex and two the other, but indicate that both males and females are potential hermaphrodites as believed by Darwin and Strasburger.

TABLE II.—*Alteration of Sex Ratios in* 1914

| Plant number | Number of flowers removed[2] | | Additional treatment | Number of flowers appearing after operation | | | |
|---|---|---|---|---|---|---|---|
| | | | | Under sack | | On remainder of plant | |
| | Male | Female | | Male or perfect | Female | Male or perfect | Female |
| 1 | 16,030 | 0 | Top bagged | 640 | 0 | 1,040 | 0 |
| 2[1] | 55 | 9,780 | Top bagged | 101 | 432 | 8,420 | 621 |
| 3[1] | 560 | 5,500 | Top bagged | 875 | 97 | 5,085 | 5,910 |
| 4 | 0 | 7,355 | Top bagged | 43 | 980 | 722 | 8,100 |
| 5 | 0 | 7,370 | Top bagged | 11 | 65 | 655 | 3,280 |
| 6 | 18,875 | 0 | Top bagged | ..... | ..... | ..... | ..... |
| 7 | 0 | 9,090 | Top bagged | 250 | 320 | 210 | 1,300 |
| 12 | 10,280 | 0 | Top bagged | 630 | 0 | 4,860 | 0 |
| 13 | 0 | 9,690 | Top bagged | 56 | 415 | 225 | 4,360 |
| 14 | 0 | 4,640 | Top bagged | 0 | 0 | 950 | 4,295 |
| 15 | 0 | 10,640 | Top bagged | 42 | 385 | 463 | 2,510 |
| 16 | 25,185 | 0 | Top bagged | 870 | 0 | 10,150 | 0 |
| 17 | 0 | 3,690 | Top bagged | 32 | 450 | 505 | 2,840 |
| 18 | 20,275 | 0 | Top bagged | 575 | 0 | 4,535 | 0 |
| 19 | 0 | 7,450 | Top bagged | 120 | 1,265 | 605 | 5,580 |
| 22 | 11,520 | 0 | Top bagged | ..... | ..... | ..... | ..... |
| 23 | 0 | 11,680 | Top bagged | 890 | 780 | 4,750 | 9,340 |
| 27[1] | 341 | 8,990 | Top bagged | 720 | 750 | 3,250 | 3,870 |
| 37 | 23,910 | 0 | Top bagged | 480 | 0 | 2,590 | 0 |
| 38 | 28,370 | 0 | Top bagged | 540 | 0 | 5,140 | 3 |
| 39 | 0 | 7,820 | Top bagged | 15 | 420 | 52 | 2,530 |
| 40 | 0 | 10,650 | Top bagged | 184 | 470 | 269 | 3,410 |
| 41 | 0 | 9,380 | Top bagged | 5 | 880 | 3 | 2,340 |
| 42 | 0 | 8,920 | Top bagged | 258 | 470 | 275 | 3,490 |
| 43 | 0 | 8,220 | Top bagged | 75 | 380 | 125 | 7,850 |
| 46 | 0 | 9,370 | Top bagged | 125 | 350 | 336 | 3,160 |
| 8 | 17,450 | 0 | None | ..... | ..... | 840 | 0 |
| 9 | 0 | 9,625 | None | ..... | ..... | 550 | 4,575 |
| 10 | 8,140 | 0 | None | ..... | ..... | 0 | 461 |
| 11 | 0 | 10,211 | None | ..... | ..... | 375 | 6,735 |
| 20 | 0 | 10,360 | None | ..... | ..... | 2,005 | 2,270 |
| 21 | 23,845 | 0 | None | ..... | ..... | ..... | ..... |
| 24 | 0 | 8,240 | None | ..... | ..... | 3,210 | 9,480 |
| 25 | 0 | 10,770 | None | ..... | ..... | 2,705 | 8,390 |
| 26 | 0 | 9,110 | None | ..... | ..... | 267 | 4,560 |
| 28[1] | 60 | 5,680 | None | ..... | ..... | 382 | 8,460 |
| 29 | 23,500 | 0 | None | ..... | ..... | 7,205 | 0 |
| 30 | 0 | 10,290 | None | ..... | ..... | 2,280 | 10,220 |
| 31 | 17,320 | 0 | None | ..... | ..... | 9,110 | 0 |
| 32 | 9,750 | 0 | None | ..... | ..... | 2,250 | 1 |
| 33 | 0 | 8,460 | None | ..... | ..... | 215 | 5,280 |
| 34 | 0 | 10,530 | None | ..... | ..... | 850 | 8,410 |
| 35 | 0 | 9,760 | None | ..... | ..... | 45 | 6,770 |
| 36 | 23,440 | 0 | None | ..... | ..... | 1,060 | 0 |
| 44 | 10,440 | 0 | None | ..... | ..... | 830 | 0 |
| 45 | 15,360 | 0 | None | ..... | ..... | 1,560 | 0 |
| 47 | 0 | 6,890 | None | ..... | ..... | 39 | 370 |
| 48 | 0 | 4,140 | None | ..... | ..... | 400 | 1,120 |

[1] Monoecious plants.
[2] These were all the flowers on the plants at the time of operation.

# CONCERNING PREPOTENCY

## The Idea Belongs to Practical Live-Stock Breeders, Not to Geneticists—How Prepotency May be Obtained by Breeders—How It May Be Explained By Geneticists.

THE EDITOR

The term "prepotency" is one which originated among practical breeders, not geneticists. It is a descriptive term which has been found useful for covering a number of different, but related, facts. It has the further merit, scientifically, that it describes these facts without implying adhesion to any hypothesis which, in its application to these facts, has not yet been proved.

It is as a descriptive term that live-stock breeders habitually use the word, and it is in this sense that I used it in writing about Brigham Young; An Illustration of Prepotency, in the February issue of this journal.

A member of this association, who prefers to remain anonymous, writes that he is "greatly moved" by the article, which ascribes the quality of prepotency to Brigham Young; first because he doubts whether my use of the term prepotency is correct and second because he doubts whether on the evidence presented Brigham Young had the superior influence as a parent which has been ascribed to him. As prepotency is a subject of general interest and of first importance to stock breeders as well as to students of genetics, it is worth while to give it further consideration.

First let us decide what prepotency means. The Century Dictionary is in accord with the usage of the breeders when it defines the word as meaning "preeminent in power, influence, force or efficiency; prevailing; predominant." As applied to heredity the dictionary says it would mean *of superior power or influence in hereditary transmission*, as a quotation cited from Darwin shows. If we turn to Darwin's discussion of the subject in *Animals and Plants*, we find that he was unable to formulate any general rules concerning prepotency, superior influence seeming to inhere (1) in some cases in one character as against a contrasted one (cases we should now describe as due to Mendelian dominance), while in other cases superior influence seemed to inhere (2) in one sex (cases which he described as sex-limited inheritance and which are now known to form a special category of Mendelian inheritance). In still other cases (3) Darwin believed one race or species to have superior influence in crosses with another race or species.

### DARWIN'S EXAMPLES

As examples which we should place in category (1) Darwin mentions "purple-blossomed" peas as prepotent in crosses with "white-blossomed," and fowls of normal plumage as prepotent in crosses with silkies. Fantail pigeons he regards as lacking prepotency in crosses with pouters and barbs, yet records the occurrence of a silky sub-variety of fantails which invariably transmits its silky feathers in crosses. Hence lack of prepotency does not inhere in fantails as regards all their characters but only as regards their fantail character. Other examples belonging in our category (1) noted by Darwin are dun color in horses, dark spotting in sheep, hornlessness in cattle, normal flowers of the snapdragon and of Linaria in crosses with peloric flowers.

As examples which we should place in category (2) Darwin mentions color-blindness in man, "the hemorrhagic diathesis" (haemophilia?) and certain plumage characters of poultry and pigeons more often transmitted by males than by females.

As examples of category (3) Darwin mentions the ass as prepotent in crosses with the horse, "the prepotency in this instance running more strongly through the male than through the female ass, so that the mule resembles the ass more strongly than does the hinny." He

**IS THIS SIRE PREPOTENT?**

A West African Negro, his English wife, and their nine children. To a white observer, the father would appear at first sight to be prepotent, in determining the visible characters of the offspring; but, says a member of this association, "these children resemble their *mother* as well as their father. The children are of intermediate skin-color, hair form, breadth of nose and thickness of lips. The characters of the mother are as truly dominant as those of the father." He therefore considers it ambiguous and inaccurate to say that the Negro and the Chinese are "prepotent" in crosses with the white race. After Bond, *Journal of Genetics*, II, 2. (Fig. 20.)

further cites on the authority of Gärtner some species crosses of Nicotiana (tobacco), stating that *N. vincæfloræ* is prepotent in crosses with *N. paniculata*, but that in crosses with *N. quadrivalvis* the latter is prepotent. Numerous and extensive studies made in recent years of Nicotiana hybrids show beyond question that the prepotency (dominance) inheres in single characters, not in the characters of either parent as a group. The same is in all probability true of horse-ass hybrids, but the sterility of all such hybrids has precluded demonstrative breeding tests.

On the whole we find in Darwin's examples abundant illustrations of Mendelian unit-character inheritance, but no clear case of anything else. Darwin was evidently confused on the subject; and of course he knew nothing about Mendelism. He failed to distinguish between prepotency of one or more *characters* in an individual and prepotency of the *individual as a whole*.

The live-stock breeders of the present day likewise fail to make this distinction. In general, they speak as if prepotency were a function of the individual. Many modern geneticists object to this attitude, holding it to be vague and confusing; they are unable to picture clearly to themselves any way in which an animal could be prepotent as a whole, although their work with different unit-characters leads them easily to understand that an animal might have a number of prepotent or, tech-

nically, dominant characters, and therefore *seem* to be prepotent as an individual.

"But," writes my correspondent, "if there really exist, as Darwin supposed and as the literature of breeding based on pre-Mendelian conceptions implies, individuals or races having superior power of hereditary transmission as regards all their characters, their existence must be regarded as of the greatest theoretical interest and practical importance, and no effort should be spared to discover them."

### THE CASE OF BRIGHAM YOUNG

The illustration of Brigham Young in the February issue of this journal, seemed to my correspondent to be an attempt to demonstrate a case of individual prepotency. As a fact, I expressed no opinion as to whether the prepotency was general or was confined to certain characters; I enumerated certain characters as indications of prepotency and left the reader to interpret them as he liked. Shape of mouth and nose were mentioned as being strikingly alike in father and daughters, and a friend of the Young family was quoted as saying that "all the daughters are distinctly Youngs in feature, voice, appearance and temperament. . . . None is great as their father was great, but all are Youngs."

Interpreting this as a claim of general or individual prepotency, my correspondent writes:

"Is the case of Brigham Young evidence of individual or racial prepotency? The evidence is incomplete. We may admit that the daughters look like their father. Most daughters do. They probably also look like their mothers. We have no means of judging whether they look *more* like one parent than the other, because the picture of the other parent is not given for comparison. Yet this is the very point on which we are asked to pass judgment. The jury calls for *Exhibit B*, the pictures of the mothers, before bringing in a verdict.

"There are in the group of daughters, according to the legend, three pairs of full sisters. These three pairs are plainly more like each other in features and expression than any other pairs which can be formed within the group. This fact shows that the mother as well as the father had influence in determining the features of these daughters. Which had the *greater* influence, the mother or the father, we have no means of judging.

"The author speaks of shape of nose and mouth as being features in which resemblance is shown to the father. Suppose this be granted. No two have noses and mouths exactly alike. Perhaps the mothers had something to do with these differences. But even if there were practical identity between father and daughters in shape of nose and mouth, we should be dealing with two single characters only. These might be *dominant characters*, but that would not prove Brigham Young a *dominant parent*.

"Suppose we examine a photograph, which Bond (*Journal of Genetics*, 1912) has published, of an English woman, her West African husband, and their nine children, for evidence of prepotency. (See Fig. 20.) The children all have dark skin, black curly hair, broad noses and thick lips, in all of which features they resemble their father. Surely, you might say, this is a prepotent sire. But these children resemble their *mother* as well as their father. The children are of *intermediate* skin-color, hair form, breadth of nose and thickness of lips. The characters of the mother are as truly dominant as those of the father. A white race calls the children *black*-hybrids, but a black race might with equal propriety call them *white*-hybrids. A study of later generations would probably show also that the several characters observed in the children vary independently of each other in later generations, that they are not a group of correlated characters at all."

The illustration given is particularly pertinent, because anthropologists have often spoken of the negro (and also the Chinese) as prepotent in racial crosses with whites. It cannot be denied that this is a loose use of the term, which is not likely to be of much value to science. I do not consider that the illustration of the negro-white

cross is wholly parallel to the illustration of Brigham Young and his daughters; I am still of the opinion that the daughters, despite the fact that they come from eight different mothers, resemble each other as much as do ordinarily the children of a single mother; and I am of the opinion that the father may therefore properly be called prepotent, as the term is ordinarily used. It seems to me that the uniformity of mouth, nose and ears furnishes a good illustration. But I certainly would not lay much weight on the illustration as an evidence of the existence of either character prepotency or individual prepotency; it is nothing more than an illustration, although as good a one as I have ever seen in human material. To get any real light on the problem, I think we must stay in the field of live-stock breeding, where the problem arose.

### MR. ROMMEL'S OPINION

To get light here we called on the secretary of the American Genetic Association for information as to the attitude of intelligent modern breeders; he was asked particularly whether in regard to individual prepotency geneticists had from their more limited experience overlooked a principle recognized among practical breeders. His reply is as follows: "Concerning individual prepotency, I will say that this has been made the subject of two of the regular Saturday afternoon conferences of the officers of the division. It is the consensus of opinion that from the standpoint of the geneticist there is no such thing as individual prepotency in animals; that is to say, that no animal is prepotent in every character. There have been many animals that were prepotent in certain characters, or even in many characters. From the standpoint of the practical breeder there is individual prepotency in that certain animals have been prepotent in producing the things for which the breeder is striving.

"The inbreeding by which a character of interest is made prepotent will automatically make the factors affecting other characters homozygous, will give some prepotency to these characters (as far as they are due to dominant factors), and will give the individual an appearance of individual prepotency.

"As an example may be mentioned the case of the Standard-bred stallion, Peter the Great, 28955. He has 216 sons and daughters with records of 2.30 or better. This is a good example of prepotency in the matter of speed and included with this must be various other characters, not measurable perhaps, which enable these horses to go a mile in such fast time.

"There are on record a few other stallions which have more sons and daughters with records of 2.30 or better, but none of these stallions is living at the present time.

"As other examples may be mentioned famous Holstein and Guernsey bulls, famous because of the fact that they have sired a large number of daughters which have made records large enough to admit them to the Advanced Register. In order to make these records these animals must have had the requisite constitution, capacity, and nervous temperament, without which such records would not have been possible. The sires were undoubtedly prepotent in such characters but these are not measurable.

"One of the best examples of prepotency in beef cattle is that of the Shorthorn bull Avondale. This bull has sired a large number of excellent bulls and heifers indicating that he was prepotent in a large number of characters.

"I trust that this statement will give you a clear idea of what is in our minds; I think that it is the idea in the minds of practical breeders.

"Very truly yours,

"GEO. M. ROMMEL,

"*Chief, Animal Husbandry Division, U. S. Department of Agriculture.*"

Evidently, then, the idea of individual prepotency which the breeders hold, and by which they mean that a certain animal has superior influence in hereditary transmission, covers many causes or supposed causes. Thus in one connection or when used by one person it may mean (as it actually does in

Darwin's "Animals and Plants," (1) Mendelian dominance (2) sex-limited Mendelian inheritance or (3) predominance as a group of the characters of one parent over those of the other. In other cases it may mean only (4) a high degree of excellence as regards some inherited character or the ability to transmit the same.

### BREEDERS' EXPLANATIONS

If we go a little farther and inquire what explanations the breeders have offered for the various results that they lump together under the name of individual prepotency, we find these:

1. "Maximum efficiency of all organs," as indicated "in the expression of the countenance and in the general bearing, behavior and carriage,"[1] or, in a word, vigor.

2. Existence of the breed for a long period of time "on a favorable soil."[2]

3. Length of time in which a variety or breed has been under domestication. "It is generally assumed that an old species or variety is prepotent over a more recent species or variety."[3]

4. Mutation. "High prepotency does not arise through normal variation, but must rank as a heritable sport or aberrant variation."[4]

5. Accompaniment of a mutation. "In nature, prepotency may arise spontaneously and abruptly along with sports in one or more directions."[5]

6. As a result of natural selection, through a gradual process of evolution.[6]

7. Inbreeding.

8. "Purity of blood."

9. Sexual development.[7]

10. "The lack of affinity in certain characters, which makes it difficult to blend them."[8]

11. Telegony.[9]

12. Maternal impression.[10]

13. Physiological relation between dam and offspring, which is supposed to make the dam prepotent over the sire.[11]

14. Relative maturity of parents, old animals being thought to be prepotent over very young ones.[12]

15. Degree of ripeness of germ-cells, fully mature gametes being prepotent over immature gametes.[13]

16. Relative strength of "nervous organization"—whatever that may mean.[14]

17. Degree of functional development, either of an individual or of his immediate ancestors.[15]

Certainly we have here a beautiful example of a term that means all things to all men. Some writers regard it clearly as a function of individual characters, others regard it clearly as a function of individual animals, others do not stop to ask what it does mean; others look on it as a highly variable quantity, as J. Cossar Ewart, who says:[16]

"An animal (male or female) may be prepotent in some respects and not in

---

[1] Marshall, F. R. Breeding Farm Animals, p. 90. Chicago, 1911.
[2] Von Oettingen, B. Horse Breeding, p. 222. London, 1909.
[3] Ewart, J. Cossar. The Pennycuik Experiments, p. xii. London, 1899.
[4] Galton, Francis. Nature (London), July 14, 1898.
[5] Ewart, *op. cit.*, p. 44.
[6] *Ibid.*
[7] Cf. Dexter, William Hart. Methods Used by the American Jersey Cattle Club in Perfecting the Breed. In A. B. A. Proc. IV (1908), p. 37: "Prepotency will be shown in the general appearance, which should be thoroughly masculine in character, with a harmonious blending of the parts with each other. There should be evident vigor, style, alertness, and a resolute appearance with abundant nervous energy."
[8] Shaw, Thomas. Animal Breeding, p. 105. New York, 1901.
[9] *Ibid.*
[10] Or even "paternal impression"! A genealogist writes me with reference to the Brigham Young photographs: "I fancy that I can see that the force of affection, which may exist in the heart of either parent at the time of creation, determines where the likeness will fall. . . . The one who loves the most copies in the offspring the features of the one loved."
[11] Mentioned by Davenport, E. In Breeders' Gazette, vol. lx, p. 82. Chicago, 1911.
[12] Ewart, J. Cossar, Address to Zoological Section, British Association, 1901; quoted by Reid, G. Archdall. The Principles of Heredity, p. 69. New York, 1905.
[13] *Ibid.*
[14] Cited by Davenport, E. Principles of Breeding, p. 568. Boston, 1907.
[15] This is the idea developed by C. L. Redfield in Dynamic Heredity (New York, 1915) and elsewhere.
[16] The Pennycuik Experiments, p. 44.

others (and this whether the prepotency has been acquired through inbreeding or as a 'sport'), or prepotent with one mate and not with another, or prepotent one year and not the next; because prepotency is of necessity subject to the influence of variation and reversion, and also doubtless of nutrition—more especially of the germ-plasm prior to fertilization."

### THE COMMERCIAL ELEMENT

When a term has so many and so varied explanations, it might seem impossible to comprehend them all in any one definition. But if we view the question solely from the standpoint of the stock-breeder, I think we will find that these definitions really are summed up in one idea. To him, prepotency is less a genetic than a commercial question: the prepotent sire is the one that produces a large proportion of offspring of high market value because of their possession in an eminent degree of the valuable commercial characters of the breed.[17]

From a genetic point of view, unfortunately, we can not reduce this complexity to simplicity, as we have done from the practical breeder's point of view by assuming that it is, in the last analysis, merely a matter of dollars and cents.

If we analyze "prepotency" from the standpoint of the geneticist, rather than that of the breeder, we find that it may appear in a number of ways, and that of two animals, one may be the more prepotent in one respect, the other in another. Its prepotency may be shown by

1. Greater influence on the mean grade of the offspring.
2. Greater uniformity in offspring.
3. Greater influence (1 or 2) on second and later generations.
4. Influence (1, 2, or 3) in greater variety of crosses.
5. Influence (1, 2, 3, or 4) in greater number of characters.

Facing such a situation, I think geneticists might well avoid the use of the term "prepotency" and employ more definite words to express more circumscribed ideas. But I do not think this need deprive live-stock breeders of the use of the term, as some geneticists would insist. After all, the word is the property of animal breeders, who use it to cover a fairly definite result, although a result that may be reached in various ways and capable of various explanations.

My position in regard to prepotency, in short, is that it is a descriptive term belonging to practical breeders, not to geneticists. It is used by breeders in a way that they understand and find useful. The geneticist should not try to interfere with this use unless he can substitute something better; and at present I do not think he can.

### THE MENDELIAN EXPLANATION

What he offers is, in general, the idea of dominance of Mendelian characters, to replace the idea of dominance (prepotency) of an individual.[19] There is room for a good deal of discussion on this point, and I shall not take time here to discuss it. What the breeder wants is prepotent animals, and what he wants the geneticist to tell him, is how he shall proceed to get them.

I mentioned, in the note on Brigham Young, three possible methods: (1) consanguineous marriage; (2) assortative mating; (3) chance. The live-stock breeder might term these (1) inbreeding, (2) pure-breeding, (3) haphazard breeding or random mating.

Of these, the first is considered by general recognition among intelligent students of breeding, to be the quick and effective way of securing prepotent animals. No student of pedigrees can doubt that inbreeding does result in prepotency.

---

[17] This suggestion was made by Dr. Sewall Wright of the Bureau of Animal Industry, at the conference mentioned by Mr. Rommel. To Dr. Wright I also owe the five-fold division of the subject from a genetic point of view, which is given a few paragraphs later.

[18] Hover, J. M. Finding the Prepotent Sire. JOURNAL OF HEREDITY, vii, No. 4, pp. 173–178, April, 1916.

[19] See *e. g.*, Wentworth, E. N. Prepotency. JOURNAL OF HEREDITY, vi, No. 1, pp. 17–20, January, 1915.

Starting from this observed fact, it is very easy to frame a hypothetical explanation of why inbreeding and pure-breeding produce prepotency. Most geneticists would probably agree on it.

The explanation which fits the facts is this: that prepotency is due to the presence of a number of *homozygous* factors for the valuable characters of the breed.[20] Ordinarily these factors will have to be dominant, but it is not difficult to think of cases where prepotency, within a single herd, say, might be due to the possession of homozygous recessive factors.

Inbreeding will make factors homozygous, if they were not so to start with. So will pure breeding, the mating of like with like, accompanied by selection, as it usually is. It is therefore easy for a Mendelist to see why a purebred animal is ordinarily prepotent over a scrub.

Further, although the breeder is selecting for only a few characters, and rendering these homozygous by appropriate mating and selection, he is automatically, at the same time, making other characters homozygous. Making a breed homozygous (*i.e.*, prepotent) in one dominant character will tend to make it homozygous (*i.e.*, prepotent) in all dominant characters. Thus the appearance of "individual prepotency" will be increased.

I do not say that this is the explanation of prepotency, but it is at least an explanation which, so far as I can see, brings the observed facts in harmony with Mendelian results.[21]

Whatever be the origin of prepotency, from a genetic point of view, the experience of breeders leaves little doubt as to the best course to follow, in the light of our present knowledge, if one wishes to secure that commercially valuable result known as prepotency. It may be expected from the mating of the best animals, selected to the same standard (*i.e.*, pure-bred) or better still, related by blood; and by selection in each generation of the animals that have the desired character in the highest degree.

The prepotency thus obtained is a measurable fact. It can be explained by a Mendelian hypothesis which makes it a matter of homozygous, dominant characters; but such an hypothesis is, in respect to the valuable traits of farm animals, still unproved and I do not think we are in a position to say whether or not it covers the whole ground. And until the geneticists have supplied the necessary proof, practical breeders will continue to talk about prepotent individuals, when they refer to individuals that are prepotent in a certain number of commercially valuable characters.

---

[20] Since we are dealing with hypotheses, I add that this condition should be accompanied by a minimum number of necessary complementary factors and a maximum number of duplicate factors; and, as Wentworth suggests, linkage may also be involved.

[21] It is quite possible that the breeders are right in claiming that inherited vigor plays a part in prepotency. If so, this would make a very near approach to that "individual prepotency" which some of the geneticists think impossible. Until proof is forthcoming, it would be well to keep an open mind and not say that there is no such thing as individual or general prepotency, even though many supposed cases of it are shown to be merely cases of character prepotency.

# Genetics Literature

THE annual reports of the AMERICAN BREEDERS' ASSOCIATION, published in seven volumes, form the most valuable collection of material for students of genetics which has been published in the United States. Most of them are out of print and are becoming very valuable. All of them are nearly indispensable to libraries, institutions and students of plant and animal breeding, heredity, variation, eugenics, or genetics in general.

The Association still has on hand a limited number of copies of three of these reports, which it offers for sale.

**Vol. VI, Proceedings A. B. A. (1910),** contains 465 pages. Illustrated. It includes 80 papers on general genetic subjects, and among the contributors are practically all the leaders in this study in the United States. **Issued at $2, now offered for $1.**

**Vol. VII, Proceedings A. B. A. (1911), and Vol. VIII (1912),** bound in one volume of 593 pages, illustrated, and including 73 monographs on the most vital and interesting features of genetics. **Issued at $3, now offered for $1.50.**

The volumes are substantially bound in cloth and will be sent post-paid on receipt of price.

---

**As the Association frequently receives requests for other volumes of the proceedings, which are now out of print, it will be glad to hear from those who have copies for sale or exchange.**

---

In addition to its annual reports, the Association still has on hand a few copies of the following issues of the AMERICAN BREEDERS' MAGAZINE:

**Vol. I, Nos. 2 and 4.**
**Vol. II, Nos. 3 and 4.**
**Vol. III, No. 2.**
**Vol. IV, Nos. 1 and 4.**

JOURNAL OF HEREDITY:

**Vol. V, Nos. 5, 6, 8, 9, 10, 11 and 12.**
**Vol. VI, Nos. 2, 3, 4, 5, 7, 9, 11 and 12.**

Each of these issues contains numerous articles on plant and animal breeding and eugenics, written by specialists and in most cases describing the results of their own researches. In many instances these researches have never been described elsewhere. These numbers will be sold for 25 cents each, post paid.

---

**Address**

**THE AMERICAN GENETIC ASSOCIATION**

**511 Eleventh Street Northwest** **WASHINGTON, D. C.**

## WHAT GENETICS IS

**"An exact determination of the laws of heredity," says William Bateson, "will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be clearly foreseen."**

To gain this knowledge is the object of the science of genetics, which proceeds, in practice, largely by means of plant breeding and animal breeding, for the reason that heredity is less complicated in these organisms than in Man, and its operation can be more easily made out. The knowledge so gained finds its application in methods for the improvement of cultivated plants and domesticated animals and, most important of all, in the improvement of the human race through the science of eugenics, which was defined by its founder, Francis Galton, as "the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally."

## THE AMERICAN GENETIC ASSOCIATION

is an incorporated organization, co-operative in nature and devoted to promoting knowledge of the laws of heredity in the broadest sense of the word, and their application to the improvement of plants, animals, and human racial stocks. It is the largest organization in the world for the advancement of genetics, and its organ, The Journal of Heredity, is the most important agent for furthering the interchange of ideas between investigators of different phases of these problems, and for the presentation of their results to the public.

Through its committees on research, co-operation with which is not obligatory, but is urged upon every member, the association collects information by means of approved scientific methods applied to the subject of genetics. This information, as well as that derived from other authoritative sources, it endeavors to place before the public by means of its committee on education and extension, and before its membership, in an attractive and understandable way, through this magazine. The association constantly strives to further the cause of conservative, constructive science and to check the progress of fallacious and sensational pseudo-science. While it can not assume responsibility for the accuracy of statements made by contributors to The Journal of Heredity, it endeavors to publish only such as are on a sound scientific basis, and members are urged to contribute such articles, with illustrations. The magazine does not pretend entirely to cover the immense field of genetics, but it is designed to keep members informed of the latest results in research in the most interesting lines, and to present these results in such a way that they will appeal not only to the specialists, but to the general reader who desires to know what the specialists are doing in a science that is of such personal importance to each individual.

## REQUIREMENTS FOR MEMBERSHIP

Membership is composed of scientists, teachers, publicists, physicians, clergymen, students, horticulturists, and breeders of live stock, throughout the world. Subject to the approval of the council, any person interested in the improvement of the human race or the creation of better varieties of plants and animals, is eligible for membership. The secretary will be glad to correspond with those interested, and to send a copy of the magazine for examination. Annual dues, giving the right to attend all meetings and to receive the Journal of Heredity, are $2; life membership is $50. Address all communications to

**THE AMERICAN GENETIC ASSOCIATION**

**511 Eleventh Street Northwest** **Washington, D. C., U. S. A.**